THE JOURNAL OF THE CINCINNATI SOCIETY OF NATURAL HISTORY.

PUBLISHING COMMITTEE:

S. A. MILLER, F. W. LANGDON,
C. F. LOW, J. F. JUDGE,
GEO. W. HARPER.

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THE JOURNAL

OF THE

CINCINNATI SOCIETY OF NATURAL HISTORY.

VOL. III. CINCINNATI, APRIL, 1880. No. 1.

CONSTITUTION AND BY-LAWS OF THE CINCINNATI SOCIETY OF NATURAL HISTORY.

ADOPTED MARCH 2, 1880.*

ARTICLE I.

The Society shall be called the Cincinnati Society of Natural History.

ARTICLE II.

It shall consist of resident, corresponding and honorary members.

ARTICLE III.

Any person residing in the City of Cincinnati, or its immediate neighborhood, shall be eligible as a resident member of the society. All members shall be chosen by ballot, after having been nominated at a preceding meeting. The affirmative votes of three fourths of the members present shall be necessary to a choice. The nomination of corresponding and honorary members shall proceed from the executive

* At the regular meeting of the Society, December 2, 1879, on motion of Dr. J. F. Judge, a committee of three, consisting of Dr. J. F. Judge, G. W. Harper, and S. A. Miller, was appointed to revise the Constitution and By-Laws of the Society. This committee reported their revision to the Society, at the regular meeting, on January 6th, 1880. It was ordered to be printed and made the special order of business for the February and March meetings. At the meeting of February 3d, 1880, the Constitution, as reported, was read and amended, and passed by a three fourths' vote of all the members present. It was again taken up at the regular meeting of March 2d, 1880, and adopted by the necessary vote of the members of the Society.

board. Any resident member who shall at one time contribute fifty (50) dollars to the funds of the society, shall be a life member, free from assessment.

ARTICLE IV.

Resident members only shall be entitled to vote, or to hold office. Corresponding and honorary members may attend the meetings and take part in the scientific discussions of the society.

ARTICLE V.

SECTION 1. The officers of the society shall be a president, two vice-presidents, a secretary, a treasurer, a librarian, curators, and four (4) members elected at large for the executive board, and two trustees as provided for in Section 3 of this article. They shall be elected annually, at the meeting in April, and shall hold office for the term of one year, and until their successors are duly elected.

SEC. 2. The president, two vice-presidents, secretary and treasurer, and the four (4) members elected at large for the executive board, shall together constitute a board for the management of the concerns of the society, not otherwise provided for in this constitution, and be called the executive board. Five (5) members of the board shall be a quorum for the transaction of business.

SEC. 3. Two trustees shall be elected at the next annual meeting, one of whom shall hold office for the term of one year, and the other for two years, and thereafter there shall be elected annually one trustee who shall hold his office for two years: and these two trustees, together with the treasurer of the society, shall be intrusted with and have charge of, all funded property of the society, with power to sell and re-invest according to their judgment. Bonds shall be required of these trustees, in such sums, and with such sureties, as may be satisfactory to the executive board; but the treasurer shall not be required to give bond both as treasurer and as trustee.

ARTICLE VI.

Officers shall be chosen by ballot, and a majority of votes shall be sufficient for a choice.

ARTICLE VII.

By-Laws for the more particular regulation of the society shall from time to time be made.

ARTICLE VIII.

This Constitution may be altered or amended in any of the preceding articles by a vote to that effect of three fourths of the members

present at any two consecutive meetings of the society, the members having been first duly notified of any proposed alteration, but the article which immediately follows this shall be unalterable.

ARTICLE IX.

The consent of every member shall be necessary to a dissolution of the society. In case of a dissolution the property of the society shall not be distributed among the members of the society, but donors may claim and receive such donations as they have made to the museum, and the remainder shall be given to some public institution, on such conditions as may then be agreed on, and the faithful performance of such conditions shall be secured by bonds, with sufficient penalties for the non-fulfillment thereof.

BY-LAWS.*

ARTICLE I.—MEMBERS.

SECTION 1. Nominations for membership shall be made in writing, by three (3) members, at least one month previous to the time of election. Such nominations shall be referred to a committee, consisting of the president, secretary and treasurer, who shall report upon the same before balloting. Every person elected a resident member shall, within six months from the date of his election, pay into the treasury an initiation fee of five (5) dollars, and subscribe an obligation promising to conform to the Constitution and By-Laws of the society; and, until these conditions are fulfilled, he shall possess none of the rights of membership, nor shall his name be borne upon the roll of members.

SEC. 2. Corresponding members shall consist of persons residing at a distance from the city, who may be interested in the study of natural history, or desirous of promoting the interests of the society. Honorary members may be selected from persons eminent for their attainments in science, on whom the society may wish to confer a compliment of respect: neither shall be required to pay an initiation fee or make any contribution.

SEC. 3. No person whose application for membership has been rejected, shall be again proposed within one year of the date of said rejection.

SEC. 4. Any member may withdraw from the society by presenting his written resignation, and paying all arrearages due from him. Mem-

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* At the meeting of March 2, 1880, the 1st Article of these By-Laws was considered in committee of the whole. At a special meeting of the Society, March 30, 1880, the By-Laws were adopted.

bers who shall be in arrears for the dues of one year shall *not* be entitled to vote, hold office or to receive any of the publications of the society until such arrearages are fully paid: and if not paid within one year thereafter, membership shall be forfeited.

SEC. 5. Members may be expelled from the society by a vote of three fourths of the members present at a regular meeting, written charges having been preferred, a copy of which shall be furnished the accused at least one month previous to such vote, and the accused shall have opportunity to be heard thereon.

ARTICLE II.—OFFICERS AND THEIR DUTIES.

SECTION 1. The President shall preside at the meetings of the society, and of the executive board, and perform such other duties as usually pertain to the office.

SEC. 2. The Vice-Presidents shall perform the duties of the president in his absence, in the order of seniority in office.

SEC. 3. The Secretary shall record and preserve correct minutes of the proceedings of the society, and the executive board, in books to be kept for that purpose; shall have the charge of all records belonging to the society; shall notify members of their election, and committees of their appointment; shall call special meetings, when directed by the president; and shall notify all resident members of all meetings, and officers of all matters which shall occur at any meeting requiring their action. He shall also conduct the correspondence of the society, and shall keep a record thereof, shall keep the common seal, acknowledge all donations, and receive and read to the society all communications addressed to it.

SEC. 4. The Treasurer shall have charge of all money or other property of the society, excepting the museum and its contents, and excepting also such property as may be placed by the society or the executive board in the hands of the trustees; shall collect all fees and assessments, and receive all donations in money which may be made to it; shall pay all accounts against the society when the same shall be approved by a vote of the executive board; shall keep a correct account of all receipts and expenditures, in books belonging to the society; and shall at each annual meeting, and at other times when required by the executive board, make a detailed report of the same. He shall notify members, who are in arrears, of their indebtedness to the society, and shall report all delinquencies to the executive board annually.

SEC. 5. The Librarian shall have charge of the books belonging to

the society, or deposited for its use, and of the publications of the society; he shall observe and enforce such regulations as the executive board shall from time to time make for the use of the books. He shall have charge of the distribution, sale and exchange of the publications of the society, under the direction of the executive board.

Sec. 6. The Curators shall be *ex-officio* chairmen of the sections, in their respective branches of science. There shall be one curator for each of the following named branches: Mineralogy, Palæontology, Conchology, Entomology, Botany, Ornithology, Ichthyology, Archæology, Comparative Anatomy, Herpetology.

The curators shall perform such duties as may be assigned to them by the executive board.

Sec. 7. The Executive Board shall control all expenditures of money, make rules for the use of the library and museum, and determine the duties of the curators; and they shall have power to employ a custodian and prescribe his duties, provided such custodian shall not be employed for any term which shall interfere with his discharge at any time by the board, and shall elect annually a committee of five (5) members of the society, to be called the publishing committee. The Executive Board shall have full power to act for the interests of the society, in any way not inconsistent with the Constitution and By-Laws; they shall annually report to the society the condition of the museum and library.

ARTICLE III.—ASSESSMENTS.

Section 1. Every resident member shall be subject to an annual assessment of five (5) dollars, payable on the first Tuesday of April of each year, but no assessment shall be required of any member during the six months succeeding his election.

Sec. 2. The president and treasurer together shall be empowered to exempt (*sub silentio*) a member from assessment, when, from peculiar circumstances, they may deem it for the interest of the society so to do.

ARTICLE IV.—LIBRARY.

Section 1. Members of the society only shall have access to, or take books from, the library, but the executive board may, by special vote, extend the use of books to others than members, specifying the conditions under which they may be taken.

Sec. 2. The rules and regulations of the executive board, for the use of the library, shall be printed and exposed in the library rooms, and a digest of them affixed to the volumes themselves.

ARTICLE V.—MUSEUM.

SECTION 1. All members, and the public generally, shall have access to the museum, at such times as the executive board shall determine.

SEC. 2. No specimen shall be removed from the museum, except by order of the society, or for the purpose of illustrating the proceedings, and in either case the curator shall take a receipt for the same.

ARTICLE VI.—COMMITTEES.

SECTION 1. The committee on publication shall, from time to time, cause to be published, and superintend the publication of such papers read to the society, and such portions of the record of the proceedings, as may seem to them calculated to promote the interests of science, so far as the funds appropriated by the executive board shall permit, it being understood that the committee shall not be held responsible for any opinion expressed in said publications.

SEC. 2. The president shall, at every annual meeting, appoint a committee of three, whose duty it shall be to audit the accounts of the receipts and expenditures of the corporation.

ARTICLE VII.—SECTIONS AND LECTURES.

SECTION 1. For the purpose of facilitating and encouraging special investigation in the several branches of Natural Science, the members may organize sections under the chairmanship of the curator of the special branch for which the section is organized, upon such conditions and in conformity to such rules as the society may adopt.

SEC. 2. Public lectures may be delivered under the auspices of the society, whenever the executive board shall deem it expedient.

ARTICLE VIII.—MEETINGS.

SECTION 1. The regular meetings of the society shall be held on the first Tuesday of each month, those held in April, July, October and January shall be for the transaction of business; those held in May, June, August, September, November, December, February and March shall be for scientific purposes; the April meeting shall be known as the annual meeting, at which the annual reports shall be read, and the officers of the society shall be elected.

SEC. 2. Nine (9) members shall be a quorum for the transaction of business.

SEC. 3. The order of proceeding at business meetings shall be as follows:

1. Reading of minutes of preceding business meeting.

2. Candidates for membership to be proposed.
3. Election of members.
4. Reading the minutes of the executive board.
5. Business arising from the reading of minutes of the executive board.
6. Unfinished business.
7. New business.
8. Scientific communications.
9. Donations.
10. Adjournment.

The order of proceeding at scientific meetings shall be as follows:

1. Reading of minutes of preceding scientific meeting.
2. Written communications.
3. Verbal communications.
4. Candidates for membership to be proposed.
5. Election of members.
6. Miscellaneous business.
7. Donations.
8. Adjournment.

ARTICLE IX.—AMENDMENTS.

Section 1. All propositions to amend these By-Laws shall be in writing, and shall not be acted upon until the next regular meeting, when a majority vote of the members present shall be sufficient to adopt.

PROCEEDINGS OF THE SOCIETY.

The following officers were elected at the regular annual meeting of the Cincinnati Society of Natural History, held April 6, 1880:

President—Dr. R. M. Byrnes.
1st Vice-President—Dr. J. H. Hunt.
2d Vice-President—Dr. D. S. Young.
Secretary—Dr. F. W. Langdon.
Treasurer—S. E. Wright.
Librarian—S. A. Miller.
Curator of Palæontology—Prof. J. Mickelborough.
Curator of Entomology—V. T. Chambers.
Curator of Botany—Davis L. James.
Curator of Ornithology—John W. Shorten.
Curator of Ichthyology—Dr. D. S. Young.

Curator of Archæology—Dr. H. H. HILL.

Curator of Comparative Anatomy—Dr. A. J. HOWE.

Curator of Herpetology—Dr. W. A. DUN.

Members at large for the Executive Board—Dr. J. F. JUDGE, Dr. H. H. HILL, Prof. G. W. HARPER and Mr. C. F. LOW.

Trustees of the Society—Mr. JULIUS DEXTER, 2 years; Mr. R. B. MOORE, 1 year.

The election of Curators of Mineralogy and Conchology was postponed until the regular meeting in May.

The President appointed S. A. Miller, Dr. J. F. Judge and R. B. Moore as a committee to audit the Treasurer's accounts.

The Treasurer's annual report will be found in another part of this Number.

On motion of Mr. J. M. Edwards, the material in the section on Microscopy was placed in charge of the Curator of Comparative Anatomy.

Mr. Alfred Mack, Archibald Potter and Ralph L. R. Colvin were elected members of the society.

The Literary and Scientific Society of Madisonville presented a human cranium from the ancient cemetery near Madisonville. Dr. F. W. Langdon presented several species of batrachians and reptiles ; and Charles Peale a botanical specimen.

EXECUTIVE BOARD.

The Executive board met immediately after the adjournment of the meeting of the society on April 6, and after transacting some business adjourned to meet on April 9th. At a full meeting of the board at the latter date, rules for its government in the transaction of business were adopted, and the time for regular meetings fixed on the third Tuesday of each month, at 3½ o'clock P. M.—to be held at the rooms of the society. On motion, the following gentlemen were elected to constitute the publishing committee of the society, viz: S. A. Miller, F. W. Langdon, C. F. Low, J. F. Judge and G. W. Harper.

NORTH AMERICAN MESOZOIC AND CÆNOZOIC GEOLOGY AND PALÆONTOLOGY.

By S. A. Miller, Esq.

[*Continued from Vol. 2, page 244.*]

In 1829, Dr. Morton illustrated a section of Cretaceous rocks, 27 8-12 feet in height, found in a bluff, on the margin of Crosswick's Creek, New Jersey, and separated the Cretaceous of New Jersey and Delaware into the lignite strata and the marl. He relied, in determining the Cretaceous age of the rocks, upon the genera *Terebratula*, *Gryphæa*, *Exogyra*, *Ammonites*, *Baculites* and *Belemnites.* He described,* from an excavation for the Delaware and Chesapeake canal, *Ostrea falcata*, and from other places, *Terebratula harlani*, *T. fragilis*, *T. sayi*, *Gryphæa mutabilis* and *G. vomer.*

In 1830,† he published his Synopsis of the Organic Remains of the Ferruginous Sand Formation of the United States, with geological remarks. He treated of the distribution of the strata, and mentioned many localities in the eastern and southern States where they are exposed, and also discussed the mineralogical characters of the marls. He described *Belemnites americanus*, *B. ambiguus*, *Cucullæa vulgaris*, now *Idonearca vulgaris*, *Ammonites delawarensis*, *A. vanuxemi*, *Spatangus stella*, *Ananchytes cruciferus*, *A. cinctus*, *A. fimbriatus* and *Anthophyllum atlanticum*, now *Montivaltia atlantica.* He also determined that two species, figured in Sowerby's Mineral Conchology, under the names of *Chama heliotoidea* and *C. conica*, belong to Say's genus *Exogyra.* Sowerby soon after adopted his determination, which was the first instance in which the genus of an American author was adopted in Europe, where it required the separation of the species which had been referred to an older genus.

In 1833,‡ he published a Supplement to his Synopsis, in which he illustrated and described *Rostellaria arenaria*, now *Anchura arenaria*, *Tornitella bullata*, *Conus gyratus*, *Cytherea excavata*, now *Cyprimeria excavata*, *Cardita decisa*, *Clavagella armata*, *Plagiostoma gregale*, now *Spondylus gregalis*, *P. pelagicum*, now *Lima pelagica*, *Pecten perplanus*, *P. venustus*, *Anomia argentaria*, *Gryphæa plicatella*, *Ostrea falcata*, var. *nasuta*, *O. mesenterica*, *O. tortuosa*, *O. urticosa*,

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* Jour. Acad. Nat. Sci., vol. 6, part 1.
† Am. Jour. Sci. & Arts., vols. 17 & 18.
‡ Am. Jour. Sci. & Arts., vols. 23 & 24.

Teredo tibialis, now *Polarthrus tibialis*, *Terebratula harlani*, var. *discoidea*, *T. harlani*, var. *rectilatera*, *T. lachryma*, now *Terebratulina lachryma*, *Pholas cithara*, now *Martesia cithara*, *Balanus peregrinus*, *Cidarites diatretum*, now *Cidaris diatretum*, *Clypeaster florealis*, *G. geometricus*, and *Spatangus ungula*. Some of the species which he described at this time, and referred to the Cretaceous, are now regarded as of Eocene age. Among these we may mention, *Nummulites mantelli*, which has been the subject of much discussion, and is now referred to D'Orbigny's genus *Orbitoides*, and classed with the Protista.

In 1834, his Synopsis appeared, illustrated with nineteen plates, and having an appendix, containing a tabular view of the Tertiary fossils hitherto discovered in North America. He said that he cast it, as "a grain of sand, on the mountain of geological knowledge, which has been heaped up by the genius and industry of the naturalists of both hemispheres." But the carefulness with which the work was prepared, and the sound discrimination and learning displayed upon every page, are so obvious that one is struck with astonishment, in comparing it with the peurile and hypothetical essays which emanated, at that time, from the colleges and professed teachers of geology. It was not only a valuable contribution to knowledge, prepared by a physician, during the constant interruptions of a professional life, but it was the best work which had appeared, at that time, upon American Geology, and one that will continue to be a standard of science for many decades to come.

He separated the Cretaceous into two parts, the lower, Ferruginous Sand, and the upper, Calcareous Strata. The mineralogical characters of the Ferruginous Sand are extremely variable, consisting, for the most part, however, of minute grains, collected into friable masses of a bluish or greenish or grayish color, the predominant constituents of which are silex and iron. Iron pyrites is found in profusion; succinite, lignite and spheroidal masses, of a dark green color, and compact, sandy structure are not uncommon. The calcareous strata consist of several varieties of carbonate of lime, the principal of which are as follows: an extremely friable mass, containing silex and iron, and about 37 per cent. of lime, composed almost entirely of disintegrated zoophytes ; a yellowish or straw-colored limestone, full of organic remains ; a granular or subcrystalline limestone, intermediate in structure between the former two; and a white, soft limestone, not harder than some coarse chalks and replete with fossils. All these varieties are occasionally infiltrated by silicious matter, and contain

masses of chert, and also present some appearances of the green grains so characteristic of the adjacent marls.

The Cretaceous formation is unequivocally recognized in New Jersey, from whence it may be locally traced through Delaware, Maryland, Virginia, North and South Carolina, Alabama, Mississippi, Tennessee, Louisiana, Arkansas and Missouri, it is also, probably, traced to Long Island, and probably forms the substratum of the islands of Nantucket and Martha's Vineyard. "These various deposits", he says, "though seemingly insulated, are doubtless continuous, or nearly so, forming an irregular crescent, nearly 3,000 miles in extent; and there is not only a generic accordance between the fossil shells scattered through this vast tract, but in by far the greater number of comparisons I have hitherto been able to make, the same species of fossils are found throughout: thus, the *Ammonites placenta*, *Baculites ovatus*, *Gryphæa vomer*, *G. mutabilis*, and *Ostrea falcata*, are found without a shadow of difference from New Jersey to Louisiana; although some species have been found in the latter State that have not been noticed in the former, and *vice versa.*"

The calcareous strata appear to be much less extensively distributed than the friable marls, and present considerable difference in their organic characters, and always when observed form the overlying beds of this formation.

Two sections of the strata, as observed in Delaware, are furnished. Localities of exposure are mentioned in Maryland, Virginia, North and South Carolina, Georgia, Alabama, Mississippi, Tennessee, Louisiana, Arkansas, Missouri, and in the level country between the Missouri river and the Rocky Mountains.

He described: *Nautilus dekayi*, *Ammonites navicularis*, *A. petechialis*, *A. telifer*, *A. conradi*, now *Scaphites conradi*, *A. conradi*, var. *gulosus*, now *Scaphites conradi*, var. *gulosus*, *Scaphites reniformis*, *A. vespertinus*, now *Mortoniceras vespertinum*, *A. syrtalis*, now *Placenticeras syrtalis*, *Baculites asper*, *B. carinatus*, *B. columna*, *B. labyrinthicus*, *Hamites arculus*, *H. torquatus*, *H. trabeatus*, *Trochus leprosus*, now *Phorus leprosus*, *Delphinula lapidosa*, now *Angaria lapidosa*. *Turritella encrinoides*, *T. vertebroides*, *Scalaria sillimani*, *S. annulata*, *Rostellaria pennata*, *Natica abyssina*, now *Gyrodes abyssina*, *N. petrosa*, now *G. petrosus*, *Cirrus crotaloides*, *Patella tentorium*, *Ostrea cretacea*, *O. plumosa*, *Pecten craticula*, *Placuna scabra*, *Inoceramus barabini*, *I. alveatus*, *Avicula laripes*, *Pectunculus australis*, now *Axinæa australis*, *P. hamula*, now *A. hamula*, *Arca rostellata*, now *Cibota rostellata*, *Cucullæa antrosa*, now *Idonearca antrosa*, *C. vul-*

garis, now *I. vulgaris*, *Crassatella vadosa*, *Pholadomya occidentalis*, *Trigonia thoracica*, *Venilia conradi*, now *Veniella conradi*, *Terebratula floridana*, *Serpula barbata*, *Hamulus onyx*, *Cassidulus æquoreus*, *Clypeaster geometricus*, *Flustra sagena*, now *Pliophlæa sagena*, *Eschara digitata*, *Alveolites capularis*, *Turbinolia inauris* and *Gryphæa pitcheri*. The latter species was collected by Dr. Z. Pitcher, on the Kiamechia, a stream which empties into the Red river, a few miles above Fort Towson, when on a tour with a small military force, marking out a road from Fort Smith to Fort Towson. Dr. Pitcher and M. Jules Marcou referred the rocks to the Jurassic, and Marcou claims that the species is distinct from that which abounds in the Cretaceous of Texas, and farther west which is now so universally referred to this species. The weight of authority, however, is in favor of the identity of the fossils, and the Cretaceous age of the specimens described by Dr. Morton.

In 1835, in an appendix to his Synopsis of Organic Remains, he separated the Cretaceous into upper, middle and lower divisions. In the upper division he placed the Cretaceous of South Carolina, and the *Nummulite*, or *Orbitoides* limestone of Alabama, which has since been regarded as of Eocene age. The middle division is partially seen at Wilmington, North Carolina, and to a considerable extent in New Jersey. The lower division embraces the vast Ferruginous strata of the Atlantic and Southern States. He enumerated the fossil species which he regarded as most characteristic of these divisions, and described *Plagiostoma echinatum*, now *Spondylus echinatus*.

In 1834, Dr. Harlan described* *Ichthyosaurus missuriensis*, now *Mosasaurus missuriensis*.

In 1836, Dr. Dekay described† *Geosaurus mitchelli*, now *Liodon mitchelli*.

In 1838, Prof. Bronn described,‡ from the greensand, *Mosasaurus dekayi*.

In 1840, Prof. Henry Rogers§ divided the Cretaceous, which is exposed in the southern half of New Jersey, northwest of a gentle undulating line, drawn from Shark Inlet, on the Atlantic coast, to Salem, into five separate beds, in ascending order, as follows:

First.—A group of sands and clays, of several colors, and of somewhat variable constitution, but frequently of extreme whiteness and

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* Trans. Am. Phil. Soc., vol. 4.
† Ann. Lyc. Nat. Hist. N. Y., vol. 3.
‡ Lethæa Geognostica.
§ Geo. of New Jersey.

remarkable purity. Among these occur beds of pure potter's clay. This division of the general series rests along its northwest margin, from the Raritan to the Assunpink, in an unconformable manner upon the middle secondary rocks, and from the Shipetaukin to the Delaware, upon the upturned strata of the primary belt. It contains, toward its upper beds, much of the dark blue sandy clay, which is also associated with the overlying greensand, from which it is not separated by any well-defined limit.

Second.—A somewhat mixed group, consisting of beds almost wholly composed of greensand, in a loose and granular condition, alternating with and occasionally replaced by layers of a blue, sandy, micaceous clay. This is the "greensand formation," properly so called. Having been used, however, for agricultural purposes, it has acquired the name of marl. It comprises, strictly speaking, several subordinate beds, all belonging, however, to two principal varieties. In the first of these, the green, granular mineral is the predominant and characteristic ingredient. The second consists, on the other hand, of a dark-blue clay, mingled with more or less silicious sand. This latter material constitutes the usual floor upon which the true greensand deposit rests ; and it occurs, in like manner, especially in the northern and eastern portions of Monmouth county, both above the uppermost visible greensand, and included between its beds in one or more alternations.

Third.—Immediately overlying the greensand formation near its southeastern border, there are several limited exposures of a yellowish granular limestone, of rather crystalline structure, and frequently silicious composition. This rock exists in rather irregular, thin, flaggy bands, usually from one to three inches thick. Between these there are often thin layers of loose, granular, calcareous sand, identical, or nearly so, with the matter of the rock, but destitute of cohesion. This formation contains a profusion of organic remains, many of which belong in like manner to the underlying greensand, though some occur in it alone. Resting usually in direct contact with the greensand stratum, it contains often a moderate proportion of the green granular mineral, sprinkled throughout its mass. It is useful as a source of lime in a district where there is no other calcareous stratum.

Fourth.—A yellow, very ferruginous, coarse sand, containing sometimes a small proportion of the green mineral. This stratum is in some places thirty feet thick. In the Nevesink Hills, and in one or two other localities, it occurs as a soft sandstone, containing hollow casts of fossil shells. Throughout much of the central portion of the

greensand region, this bed is in the condition of a loose sand, but abounds in organic remains in the state of solid casts.

Fifth.—Resting upon the former, and constituting the highest ascertained member of the Cretaceous series in the State, there occurs a coarse, brown ferruginous sandstone, sometimes passing into a conglomerate. It is composed of translucent quartzose sand, small fragments of felspar, and pebbles of white quartz, cemented together by a dark brown paste of oxide of iron. The green mineral in detached grains is likewise a common ingredient. The position of this rock is usually upon the summits of the insulated outlying hills, which rise occasionally above the general plain of the marl region.

This division into beds is merely descriptive of the local appearance of the Cretaceous of New Jersey, and has never been regarded as of any service in the separation of the Cretaceous, in other States, into groups, nor has it been retained in New Jersey, since the geologists have been able to separate the strata by their organic remains.

In 1841, James C. Booth, in his Memoir of the Geological Survey of Delaware, divided the Cretaceous of that State, which is found superimposed upon the primary rocks, and extends from the lower limit of the primary nearly to the southern border of New Castle county, into red clay, and green and yellow sands. He estimated the thickness at not less than 330 feet.

In this year, Prof. J. W. Bailey* discovered that a large part of the calcareous green sand of New Jersey, the limestone from Claiborne, Alabama, and a light cream-colored marl from a mission station on the Upper Mississippi, called "Prairie Chalk," is composed of microscopic shells belonging to the foraminifera.

In 1842, Dr. Morton† described, from the Cretaceous of the upper Missouri river, *Ammonites mandanensis*, *A. abyssinus* and *A. nicolletti*, all of which are now referred to the genus *Scaphites*, and to the Fox Hills Group; *Hipponyx borealis*, now *Anisomyon borealis*, *Cytherea missuriana*, now *Dione missuriana* and *Tellina occidentalis*, now *Lucina occidentalis*. And from the Cretaceous group, of New Jersey, *Ammonceratites conradi*, now *Crioceras conradi*, *Hamites annulifer*, now *Ptychoceras annuliferum*, *Pinna rostriformis*, *Terebratula atlantica*, *Planularia cuneata*, *Cidarites armiger*. And *Ptycodus mortoni*, by Mantell, from the Cretaceous, at Prairie Bluff, Alabama. Dr. James E. Dekay, described,‡ from the Cretaceous

* Am. Jour. Sci. and Arts, vol. 41.
† Jour. Acad. Nat. Sci., vol. 8, part 2.
‡ Zool. of New York.

greensand, *Gavialis neocæsariensis*, now *Thoracosaurus neocæsariensis.*

In 1843. Prof. Mather* ascertained that beneath the drift, and above the New Red Sandstone, there exists a deposit of sand, clay, gravel and pebbles. on the Island of New York, Staten Island, Long Island and Gardener's, Plum, Shelter, Governor's and Bellow's Islands, which he referred to the Cretaceous. Sections furnished by the digging of wells indicated a thickness of 80 or 90 feet. He also regarded the exposure of trappean rocks in Rockland and Richmond counties, New York, as more recent than the New Red Sandstone.

In 1844, Dr. Morton† described, from New Jersey, *Crocodilus clavirostris.* And Dr. Robert W. Gibbes, from the greensand near the Santee canal, about 3 miles from Cooper river, in South Carolina, *Dorudon serratus*, now *Thoracosaurus neocæsariensis*

In 1845,‡ Lyell and Sowerby described, from Timber creek, New Jersey, *Ostrea subspatulata*, Lyell and Forbes described *Lima reticulata*, *Terebratula vanuxemi*, now *Terebratella vanuxemi*, *Bulla mortoni*, and William Lonsdale described *Idmonea contortilis*, *Tubulipora megæra*, now *Filifascigera megæra*, and *Cellepora tubulata.*

Goldfuss described§ *Mosasaurus maximiliani*, now *M. missuriensis.*

In 1846, Dr. Ferdinand Roemer‖ ascertained the character of the Cretaceous rocks of Texas, and compared them with the chalk of Europe, and greensand of New Jersey, and claimed that they represented the upper part of the Cretaceous formation. He mentioned their occurrence at New Braunfels, and ranging very far on both sides of the Guadaloupe, and everywhere parallel to the chain of high hills which separate the Indian country from the settled part of Texas. He followed them as far as Austin on the Colorado, and collected fossils in them at San Antonio, and on the Pedernales river. East of a line drawn through San Antonio, New Braunfels and Austin, the surface is covered with strata more recent than the Cretaceous; it is generally composed of a thick diluvium of loose materials, consisting either of a fertile vegetable mould, or of rounded pieces of hydrate of iron, or of sand and gravel.

In 1848,¶ he stated that an ideal line, drawn from Presidio de Rio Grande, on the Rio Grande, in a N. E. direction, and crossing the San

* Geo. Sur. N. Y. † Proc. Acad. Nat. Sci.
‡ Quar. Jour. Geo. Soc., vol. 1.
§ Act. Nov. Leop. Caes. Nat. Cur.
‖ Am. Jour. Sci. and Arts, 2d ser , vol. 1.
¶ Am. Jour. Sci. and Arts, 2d ser vol 6.

Antonio river, at the town of the same name, the Guadaloupe at New Braunfels, the Colorado at Austin, the Brazos at the falls of this river, the Trinity below its forks, and reaching from there to the Red river in the same N. E. direction, divides the Tertiary strata, and the diluvial and alluvial deposits (of the level and rolling part of the country) from the Cretaceous and older formations (of the hilly and mountainous sections) of Texas. The tract of level country which extends like a broad belt along almost the whole coast of Texas, is diluvial and partly alluvial in character. Its small elevation of a few feet only above the level of the sea, and its perfectly level surface, indicate, at once, the recent origin of the soil. The fossil remains found in many places in the deposits of clay and sand, prove their modern age still more conclusively. At the head of Galveston Bay, and near the town of Houston, he found, at the height of 12 to 20 feet above the general level of the Bay, large deposits of shells of Gnathodon, a bivalve mollusc, which lives abundantly in the brackish waters along the coast of the Gulf of Mexico, and in the Bay of Galveston, and a few oyster shells of the common kind, but no shells different from those living in the Bay. Everything tending to show that there had been no material change in the climate, nor other circumstances since the period of these deposits along the coast of Texas, except in the relative change of the level of land and sea. To the diluvial period he referred the deposits of clay and sand which form the banks of the Brazos, and probably all the other large rivers of the country wherein he found the bones of the Mastodon, Megalonyx, Tapir and other mammals. To the same period he referred the deposits of gravel and sand, which form a broad belt of barren or poor land covered with pine and post oak timber, in the rolling or undulating portion of Texas, and extending from west to east across a considerable part of the country. Following up the Colorado from Columbus to Bastrop, or the Guadaloupe from Gonzales to Seguin, we pass directly across this belt. The gravel is mostly composed of pebbles of silex, evidently derived from decomposed Cretaceous strata. Within the limits of this gravel formation, fossil wood of dicotyledonous trees, in smaller or larger fragments, is found almost everywhere, and occasionally whole trunks of trees are met with. Near the town of Caldwell, on the Upper Brazos, he found alternating strata of brown ferruginous sandstone, and of dark-colored plastic clay, both teeming with fossils belonging to the older divisions of the Tertiary period

The Cretaceous strata which makes the most important part in the geological constitution of Texas, and chiefly her upper hilly part, is

found north of the line above indicated, covering the whole area of country with the exception of small exposures of Silurian and Carboniferous strata and granitic rocks. The Cretaceous strata constitute, generally, compact and hard rocks, some of them equaling in compactness the hardest strata of more ancient secondary formations. Generally there is an alternation of compact silicious limestones, and less compact beds of either pure or marly limestone. The former contain the silex as well diffused through their whole mass, as in separate concretions or nodules. The silicious character of these rocks, excluding the decomposing action of the atmosphere, almost entirely produces the general dry and barren aspect of the country which they occupy. He pointed out the differences between the Cretaceous fauna of Texas, and that of New Jersey and other northern localities, and compared the fauna with that of Europe, from whence he concluded that there must have existed at the time of the Cretaceous period between the continents of Europe and America, such a relation that, in both, the same modifications in the zoological character distinguished the marine fauna of the north from that of the south. From thence he drew the interesting conclusion, that the same southern inflection of the isothermal lines, which is at present so remarkable in their course from the west side of the continent of Europe, toward the east side of the continent of America, already existed at a period of the globe as remote as that of the Cretaceous formation.

In 1849, Prof Owen* described, from the greensand of New Jersey, *Crocodilus basifissus*, *C. basitruncatus*, now *Holops basitruncatus*, *Macrosaurus lævis* and *Hyposaurus rogersi.*

In 1850, T. A. Conrad† described, from Timber Creek, New Jersey, *Catopygus oviformis.*

In 1851, Dr. Gibbes‡ described, from South Carolina, *Mosasaurus acutidens*, *M. brumbyi*, *M. carolinensis*, *M. couperi*, and *M. minor.* And Dr. Leidy§ described *Discosaurus vetustus*, now *Cimoliasaurus vetustus*, and *Conosaurus bowmani.*

In 1852, Dr. D. D. Owen‖ described, from the Fox Hills of Nebraska, *Ammonites nebrascensis*, *A. cheyennensis*, now *Scaphites cheyennensis*, *A. opalus*, *A. moreauensis*, now *S. moreauensis*, *A. lenticularis*, now *Placenticeras lenticulare*, *Scaphites comprimus*, *S. nodosus*, *Ino-*

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* Quar. Jour. Geo. Soc., vol. 5.
† Jour. Acad. Nat. Sci., 2d ser. vol. 2.
‡ Smithsonian Contributions, vol. 2.
§ Proc. Acad. Nat. Sci.
‖ Rep. Geo. Sur Wis., Iowa and Minn.

ceramus sagensis, *I. nebrascensis*, and *Cucullæa nebrascensis*, now *Idonearca nebrascensis*.

Dr. Joseph Leidy* described, from the greensand of New Jersey, *Crocodilus dekayi*.†

Dr. Ferd. Roemer‡ described, from the Cretaceous rocks of Texas, *Actæonella dolium*, *Ammonites dentato-carinatus*, *A. flaccidicosta*, *A. guadalupæ*, *Arcopagia texana*, *Astarte lineolata*, *Astrocœnia guadalupæ*, *Avicula convexo-plana*, *A. pedernalis*, *A. planiuscula*, *Caprina crassifibra*, *C. guadalupæ*, *Caprotina texana*, *Cardium elegantulum*, now *Leiopistha elegantula*, *C. sanctisabæ*, *Chemnitzia gloriosa*, *Cyphosoma texanum*, *Cypricardia texana*, *Diadema texanum*, *Eulima texana*, *Exogyra arietina*, *E. læviuscula*, *E. ponderosa*, *E. texana*, *Fusus pedernalis*, *Globiconcha coniformis*, *G. planata*, *Hemiaster texanus*, *Hippurites texanus*, *Holectypus planatus*, *Homomya alta*, *Inoceramus confertim-annulatus*, *I. undulato-plicatus*, *Lamna texana*, *Lima crenulicosta*, *L. wacoensis*, *Modiola concentrico-costellata*, now *Volsella concentrico-costellata*, *M. granulato-cancellata*, now *Crenella granulato-cancellata*, *M. pedernalis*, now *Volsella pedernalis*, *Monopleura subtriquetra*, *M. texana*, *Mytilus semiplicatus*, *M. tenuitesta*, *Natica pedernalis*, now *Lunatia pedernalis*, *N. prægrandis*, *Nerinea acus*, *N. texana*, *Orbitulites texanus*, now *Tinoporus texanus*, *Ostrea anomiæformis*, *O. crenulimargo*, *O. aucella*, *Pecten duplicicosta*, now *Neithea duplicicosta*, *P. texana*, now *N. texana*, *Pholadomya pedernalis*, *Psammobia cancellato-sculpta*, now *Gari cancellato-sculpta*, *Radiolites austinensis*, *Scalaria texana*, now *Anchura texana*, *Scaphites semicostatus*, *S. texanus*, *Solen irradians*, *Spondylus guadalupæ*, *Terebratula guadalupæ*, *T. wacoensis*, *Toxaster texanus*, *Turrilites brazoensis*, and *Turritella seriatim-granulata*.

In 1853, T. A. Conrad§ described, from San Felipe creek, near Rio Grande, Texas, *Exogyra caprina*; from New Jersey, *Avicula abrupta*, *A. petrosa*, *Solenomya planulata*, now *Legumen planulatus*, *Crassatella subplana*, *Arca uniopsis*, *Tellina densata*, *Lucina pinguis*, now *Tenea pinguis*, *Pecten quinquenaria*, now *Neithea quinquenaria*, *Cardium protextum*, *Veniiia rhomboidea*, now *Veniella rhomboidea*, *Astarte parilis*, *Dentalium subarcuatum*, *Inoceramus perovalis*, *Requienia senseni* and *Pholas pectorosa*.

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* Jour. Acad. Nat. Sci., 2d ser. vol. 2

† Smithsonian Contributions, vol. 2.

‡ Kreid. von Texas.

§ Jour. Acad. Nat. Sci., 2d ser. vol. 2.

In 1854,* the Cretaceous formation of Nebraska was subdivided by Hall and Meek, in ascending order, as follows:

1. Sandstone and clay, 90 feet.
2. Clay containing a few fossils, 80 feet.
3. Calcareous marl, containing *Ostrea congesta*, scales of fishes, etc., 100 to 150 feet.
4. Plastic clays, with calcareous concretions, containing numerous fossils, 250 feet. This is the principal fossiliferous bed of the Cretaceous formation on the Upper Missouri.
5. Arenaceous clays passing into argillo calcareous sandstones, 80 feet.

These subdivisions were referred to, by these numbers, until 1861, when Meek and Hayden, in accordance with the laws of nomenclature, gave them the following geographical names: No. 1, Dakota Group; No. 2, Fort Benton Group; No. 3, Niobrara Group; No. 4, Fort Pierre Group; and No. 5, Fox Hills Group.

They described from No. 5, at Fox Hills, *Pecten rigida*, now *Syncyclonema rigidum*, from the Bad Lands of Dakota, *Baculites grandis*; from No. 4, at the Great Bend of the Missouri, below Fort Pierre, *Avicula haydeni*, *Inoceramus convexus*, *I. tenuilineatus*, *I. sublævis*, *Nucula subnasuta*, now *Nuculana subnasuta*, *Buccinum vinculum*, now *Trachytriton vinculum*, *Ammonites complexus*, *Turrilites cochleatus*, now *Heteroceras cochleatum;* from Sage creek, *Nucula ventricosa*, now *Yoldia ventricosa*, *Crassatella evansi*, *Lucina subundata*, *Dentalium gracile*, *Actæon concinnus*, now *Cinulia concinna*, *Fusus tenuilineatus*, now *Closteriscus tenuilineatus*. *Natica concinna*, now *Lunatia concinna*, *Natica paludiniformis*, now *Amauropsis*, *paludiniformis*, *Fusus constrictus*, now *Odontobasis constricta;* from No. 2, near the mouth of Vermilion river, *Inoceramus fragilis*; from below the mouth of James river, *Cytherea orbiculata*, now *Callista orbiculata* and *C. tenuis;* from No. 1, at the mouth of Big Sioux river, on the Missouri, *Pectunculus siouxensis*, now *Trigonarca siouxensis*.

Dr. Geo. G. Shumard† found the Cretaceous rocks at Fort Washita, and extending from there uninterruptedly to the southwestern boundary of the Cross Timbers, in Texas. It usually consists of grayish yellow sandstone, with intercalations of blue, yellow and ash colored clays, and beds of white and bluish white limestone. The limestone reposes on the clays and sandstones, and in some places attains a

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* Mem. Am. Acad. Arts & Sci., vol. 5.
† Expl. of Red River, of Louisiana, by Marcy.

thickness of 100 feet. It is usually soft and friable, and liable to disintegrate rapidly when exposed to the action of the weather. At Fort Washita he found Ammonites several feet in diameter, and weighing between 400 and 500 pounds.

Dr. B. F. Shumard described *Ostrea suborata*, *Astarte Washitensis*, *Cardium multistriatum*, now *Protocardia multistriata*, *Panopæa texana*, *Terebratula choctawensis*, *Globiconcha elevata*, *G. tumida*, *Eulima subfusiformis*, *Ammonites acuticarinatus*, *A. marcianus*, *Hemiaster elegans*, now *Toxaster elegans*, and *Holaster simplex*.

Dr. Leidy* described, from near Greenville, Clark county, Arkansas, *Brimosaurus grandis*, now *Cimoliasaurus grandis*. And Evans & Shumard described, from Sage creek, Nebraska, *Avicula linguiformis*, *A. triangularis*, *Solarium flexistriatum*, now *Margaritella flexistriata*, *Pholadomya elegantula*, and *Rostellaria nebrascensis*, now *Anchura nebrascensis;* and from Fox Hills, *Mytilus galpinanus* now *Volsella galpinana*.

In 1855, M. Tuomey† described, from Alabama and Mississippi, *Nautilus orbiculatus*, *N. spillmani*, *N. angulatus*, *Ammonites angustus*, *A. binodosus*, *A. carinatus*, *A. magnificus*, *A. ramosissimus*, *Turrilites alternatus*, *Turritella fastigiata Phorus umbilicatus*, now *Endoptygma umbilicata*, *Voluta cancellata*, *V. fusiformis*, *V. jugosa*, *V. spillmani*, *Fusus eufalensis*, *F. turriculus*, *Pyrula richardsoni*, now *Pyropsis richardsoni*, *P. trochiformis*, now *Pyropsis trochiformis*, *Cerithium nodosum*, *Teredo calamus*, *Panopæa cretacea*, *Pholadomya tenua*, *Cardium hemicyclus*, *Cucullæa ungula*, *Inoceramus biformis*, *I. inflatus*, *I. proximus*, *I. salebrosus*, *I. triangularis*, *Radiolites ormondi*, *R. aimesi*, *R. undulatus*, *Ichthiosarcolites cornutus*, *I. loricatus*, *I. quadrangularis*.

T. A. Conrad‡ described, from Dallas county, Miss., *Baculites annulatus*, *Hamites larvatus*, *H. rotundatus*; from Arkansas, *Ancyloceras approximans*, and *Cardium arkansasense*, now *Protocardia arkansasensis;* from Alabama, *Caprina quadrata*, and from Texas, *Rostellites texanus*, *Turritella irrorata*, *Caprina occidentalis*, *C. planata*, *Neithea occidentalis*, *Mactra texana*, *Exogyra fimbriata*, and *E. fragosa*.

Dr. Joseph Leidy§ described, from the greensand near Pemberton, New Jersey, *Pristis curvidens*.

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* Proc. Acad. Nat. Sci., vol. 7.
† Proc. Acad. Nat. Sci., vol. 7.
‡ Proc. Acad. Nat. Sci., vol. 7.
§ Proc. Acad. Nat. Sci., vol. 7.

Dr. James Schiel* found the Cretaceous rocks west of Fort Atkinson, and described *Inoceramus pseudo-mytiloides.* W. P. Blake, from the fossils collected by Capt. John Pope, identified these rocks on the banks of the Red river, near Preston; Big Springs of the Colorado; Elm Fork of the Trinity river; and a point 20 miles east of the Sand Hills, on the Llano Estacado.

In 1856, William P. Blake† announced generally the Cretaceous age of the extensive table lands on the 35th Parallel from the 101st to the 110th Meridian, known as the Llano Estacado. Though Wislizenus as early as 1848 had described it in the bluffs of Gallinas Creek, and Dr. Schiel, Dr. Randall and Lieutenant Simpson as well as Jules Marcou had testified to its existence in various places in the exposed bluffs found upon these plains. The strata are nearly horizontal, and principally white or grey and highly calcareous, but sometimes intercalated with grey or blue marl or clay. Prof. James Hall described, from False Washita and other localities in the west, *Gryphæa pitcheri*, var. *navia.*

Meek & Hayden‡ described, from near Fort Union, Nebraska (later called Fort Union Group), *Cyclas formosa*, now *Sphærium formosum*, *C. subellipticus*, now *S. subellipticum*, *Bulimus teres*, now *Columna teres*, *B. vermiculus*, now *C. vermicula*, *Pupa helicoides*, *Limnea tenuicosta*, which is made the type of the genus *Pleurolimnea*, *Physa longiuscula*, now *Bulimus longiusculus*, *P. rhomboidea*, now *B. rhomboideus*, *P. nebrascensis*, *Velletia minuta*, now *Acroloxus minutus*, *Paludina leai*, now *Viviparus leai*, *P. retusa*, now *V. retusus*, *P. leidyi*, now *V. leidyi*, *P. trochiformis*, now *V. trochiformis*, *Valvata parvula*, *Melania minutula*, now *Micropyrgus minutulus*, *M. multistriata*, now *Campeloma multistriatum*, *M. nebrascensis*, now *Goniobasis nebrascensis;* from Moreau river, *Cyrena moreauensis*, now *Corbicula moreauensis*, *Cyrena intermedia*, now *Corbicula nebrascensis;* from the Bad Lands of the Judith river, *Cyrena occidentalis*, now *Corbicula occidentalis*, *Corbula subtrigonalis*, *C. perundata*, *C. mactriformis*, *Unio priscus*, *Physa subelongata*, now *Bulimus subelongatus*, *Planorbis subumbilicatus*, *Paludina vetula*, now *Campeloma vetulum*, *P. conradi*, now *Viviparus conradi*, *Melania convexa*, now *Goniobasis convexa;* from Fort Clark, *Bulimus limnæformis*, now *Thaumastus limnæformis*, *Paludina multilineata*, now *Campeloma multilineatum*, *P. peculiaris*, now *Viviparus peculiaris;* from Little Horn river, *Planor-*

* Expl. & Sur. R. R. Miss. River to Pacific Ocean, vol. 2.
† Pacific R. R. Sur. vol., 3.
‡ Proc. Acad. Nat. Sci., vol. 8.

bis convolutus; from the Yellow Stone, *Melania anthonyi*, now *Hydrobia anthonyi;* and from near the head waters of the Little Missouri, *Cerithium nebrascense*, now *Cerithidea nebrascensis.*

From (the Fort Pierre Group)* No. 4, of the Cretaceous in Nebraska, *Actæon subellipticus*, *Turbo nebrascensis*, now *Margarita nebrascensis*, *Rostellaria biangulata*, now *Aporrhais biangulata*, *Helcion sexsulcatus*, now *Anisomyon sexsulcatum*. *H. patelliformis*, now *A. patelliforme*, *H. alveolus*, now *A. alveolus*, *H. subovatus*, now *A. subovatum*, *Bulla occidentalis*, now *Haminea occidentalis*, *Turritella convexa*, *Ammonites halli*, now *Phylloceras halli*, *Ancyloceras nebrascense*, now *Heteroceras nebrascense*, *A. cheyenense*, now *H. cheyenense*, *Avicula fibrosa*, now *Pseudoptera fibrosa;* from near the mouth of Milk river, *Bulla subcylindrica*, now *Haminea subcylindrica*, *Venus circularis*, now *Thetis circularis*, *Cytherea pellucida*, now *Callista pellucida; Cucullæa exigua*, now *Trigonarca exigua*, *Gervillia subtortuosa*, *Inoceramus incurvus*, and *Ostrea patina;* from the Great Bend of the Missouri, *Nucula obsoletastriata.*

From (the Fox Hills Group)† No. 5, of the Cretaceous in Nebraska, *Scalaria cerithiformis*, now *Chemnitzia cerithiformis*, *Natica ambigua*, now *Vanikoro ambigua*, *Natica occidentalis*, now *Lunatia occidentalis*, *Turbo tenuilineatus*, now *Spironema tenuilineatum*, *Fusus dakotensis*, *F. galpinanus*, now *Fasciolaria galpinana*, *F. contortus*, *F. flexuocostatus*, now *Fasciolaria flexuocostata*, *F. newberryi*, now *Pyrifusus newberryi*, *F. culbertsoni*, now *Fasciolaria culbertsoni*, *Pyrula bairdi*, now *Pyropsis bairdi*, *Fasciolaria cretacea*, *F. buccinoides*, *Buccinum nebrascensis*, now *Pseudo-buccinum nebrascense*, *Bulla volvaria*, now *Cylichna volvaria*, *B. minor*, now *Haminea minor*, *Turritella moreauensis*, now *Cerithiopsis moreauensis*, *Belemnitella bulbosa.*

From the mouth of Judith river, on Cherry creek, and on Moreau river, *Pholadomya undata*, now *Cymella undata*, *Goniomya americana*, *Solen subplicatus*, now *Solenomya subplicata*, *Tellina gracilis*, now *Thracia gracilis*, *Tellina Cheyennensis*, *T. scitula*, *T. subelliptica*, now *Corbicula subelliptica*, *T. prouti*, now *Thracia prouti*, *Cytherea deweyi*, now *Callista deweyi*, *Cytherea nebrascensis*, now *Callista nebrascensis*, *Corbula moreauensis*, now *Neaera moreauensis*, *C. ventricosa*, now *N. ventricosa*, *C. gregaria*, now *Corbulamella gregaria*, *Astarte gregaria*, now *Eryphyla gregaria*, *Nucula scitula*, now *Yoldia scitula*, *N. evansi*, now *Y. evansi*, *N. æquilateralis*, now *Nuculana æquilater-*

* Proc. Acad. Nat. Sci., vol. 8.
† Proc. Acad. Nat. Sci., vol. 8.

alis, *N. subplana*, *N. cancellata*, *N. planimarginata*, *Pectunculina parvula*, now *Limopsis parvula*, *Cucullæa cordata*, now *Idonearca cordata*, *C. shumardi*, now *I. shumardi*, *Mytilus attenuatus*, now *Volsella attenuata*, *Inoceramus pertenuis*, *Pecten nebrascensis*, *Natica subcrassa*, now *Lunatia subcrassa*, *Natica tuomeyana*, now *Vanikoropsis tuomeyana*, *Panopæa occidentalis*, now *Glycimeris occidentalis*, *Mactra formosa*, *M. warrenana*, *M. alta*, *Tellina subtortuosa*, now *Thracia subtortuosa*, *Cytherea owenana*, now *Callista owenana*, *Hettangia americana*, now *Tancredia americana*, *Cardium speciosum*, and *Mytilus subarcuatus*.

Professor L. Harper* described, from the bed of the Tuscaloosa, or Black Warrior river, near Erie, Greene county, Alabama, about twelve miles above the confluence of the Tombigbee and Black Warrior rivers, *Ceratites americanus*.

Dr. Joseph Leidy† described, from the greensand of Burlington county, New Jersey, *Chelonia ornata*, now *Peritresius ornatus* *Polygonodon vetus*, *Ischyrhiza mira*, *Edaphodon mirificus*, now *Ischyodus mirificus*; from Neuse river, North Carolina, *Ischyrhiza antiqua*; and from the Upper Missouri, *Cladocyclus occidentalis* and *Enchodus shumardi*. And from the Fort Union Group, at Long Lake, Nebraska, *Emys obscurus*, now *Compsemys obscurus*, *Compsemys victus*, and *Mylognathus priscus*; from the lowest lignitic of Grand river, Nebraska, *Thespesius occidentalis*, and from the Bad Lands of Judith River, *Palæoscincus costatus*, *Trachodon mirabilis*, *Troodon formosus*, *Trionyx foveatus*, *Deinodon horridus*, now *Amblysodon horridus*, *Crocodilus humilis*, now *Bottosaurus humilis*, *Lepidotus haydeni*, *L. occidentalis*, and *Ischyrotherium antiquum*, now *Ischyrosaurus antiquus*.

In 1857, Arthur Schott‡ described the Cretaceous basin of the Rio Bravo. The main portion, from Las Moras to the vicinity of Reynosa, forms a belt of 380 to 400 miles in width. The upper part of this belt commences in the vicinity of Las Moras, and terminates some few miles above Laredo, a distance of about 200 miles, whilst the lower part begins where the former ends, and reaches as far as the vicinity of Reynosa, showing a width of about 340 miles. Both of these parts are distinctly characterized by strata of greensand (chloritic chalk), which change, according to the amount of oxide of iron they contain, into

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* Proc. Acad. Nat. Sci., vol. 8.
† Proc. Acad. Nat. Sci., vol. 8.
‡ U. S. & Mex. Bound. Sur., vol. 1.

variously tinted sandstone shoals. The solidity of the strata varies very much. They are sometimes formed into very solid rocks, well suited for mechanical or architectural operations; again, they consist of loose and coarsely grained sandstone slate, which rapidly crumbles on exposure to the air. The general characteristic of this belt and its subdivisions is the strict horizontality of its strata. It is only here and there that some slight local disturbance has taken place, as for instance, near Laredo, and again, some 40 or 50 miles above, where a dip of about 8° W., S. E. and E. is exposed.

From Las Moras to the vicinity of Arroyo Sombreretillo, which is about 10 miles above Laredo, lignite coal occurs quite frequently. On both sides of the mouth of Elm creek, near Eagle pass, particularly on the north bank of this water course, layers are exposed from 3 to 4 feet thick. On the slope of Lizard Hills, below the deserted Rancho Palafox, coal occurs from 4 to 5 feet thick.

Septariæ abound in the lower belt, especially below the mouth of Arroyo Sombreretillo; on the oyster-terraces, some 40 miles below Laredo, and near the Rancho San Ignacio; on the slope of Red Ridge, of Shady Bluffs, and Septariæ Hills. Their most common shape resembles very much a small flat loaf of bread. Both on the outside and inside large irregularly shaped divisions, like a net work of veins occur, which are composed of crystals of gypsum, a mineral very abundant in these rocks.

C. C. Parry found the Cretaceous in the basin of the Rio Grande, where the Comanche trail crosses from Upper Texas into Mexico, near the Mexican settlement of San Carlos. The rock exposure exhibits a very variable dip, mostly inclined toward the west, occasionally at a very sharp angle. It rises at various points in the adjoining table-land, forming ochreous colored rocky bluffs, where at several points the gravelly table-land is seen to rest unconformably on the sharply-tilted strata. Further down the river, in an eastern direction, the Cretaceous assumes a nearly horizontal position, and a closer texture. It is here seen overlaid by a variable sheet of dark-colored lava rock. This sheet of igneous rock conforms closely to all the inequalities of the underlying limestone, exhibiting, in the walls of the Canon below, a distinct line of separation traceable for a long distance. The westerly dip of the Cretaceous underneath gradually thins out this upper igneous capping, which finally disappears, and solid limestone walls continue along the line of the river.

At one point on the line of the trail leading round the broken ranges of the mountain ledges, directly bordering the river, to reach its bed

some eight miles below the Comanche Ford, the sides of a deep washed ravine bring to view the successive and relative thickness of the rocks. We here see the upper members of the Cretaceous rocks forming the tabled summits of the adjoining mountains, and marked by frequent Cretaceous fossils, resting on a bed of igneous trap-form rock 50 to 80 feet thick, this again overlaying the closer layers of the limestone strata below.

The gigantic canon of San Carlos, through which for ten miles the Rio Grande, pursuing a nearly due east course, makes its way, presents unbroken walls of Cretaceous limestone. The course of the river cutting the strata in a line directly opposed to the dip, there is a constantly increasing elevation of the canon walls. These walls commence with a height of between 200 and 300 feet; but the fall of the water, combined with the rise of the strata, develops, in the course of ten miles, a clear perpendicular height of at least 1,500 feet above the river level.

A faint conception only can be formed from these facts of the truly awful character of this chasm. Its course can be marked along the mountain slope in a regular zigzag line, terminating by an opening cleft, which rises high and clear above the surrounding mountain ranges. The surface of the ground adjoining the river bank is a slightly broken slope, extending to the east, and showing a continuous development of the range to the north and south. The general surface presents no indication of a river course, and you are not aware of its presence till you stand suddenly on its abrupt brink; even here the running water is not always visible, unless advantage be taken of the projecting points, forming angles, along the general course of the river. From this dizzy height the stream below looks like a mere thread, passing in whirling eddies, or foaming over broken rapids; a stone hurled from above into this chasm passes completely out of sight behind the over-hanging ledges, and one can often count thirty before the last deadened splash announces that it has reached the river bed. From the point formed by its last projecting ledges the view is grand beyond all conception. You can here trace backward the line of the immense chasm, which marks the course of the river, till it emerges from its stupendous outlet.

The mountain range forming the San Vincente canon, lower down the Rio Grande, is exclusively Cretaceous. The eastern slope of the Sierra Carmel shows the Cretaceous limestone inclining eastward at an angle of about 20°; and the Cretaceous continues to be exposed almost uninterruptedly to the mouth of the Pecos river. From here to

Eagle Pass is an open country, occupied by low swells of Cretaceous limestone, thus merging into that character of country pertaining to the region of central Texas.

Prof. James Hall, to whom the minerals and fossils collected by the Boundary Commission were referred for geological examination, compared the Cretaceous of Texas and New Mexico with that of Nebraska and the eastern states. He furnished the following section of the successive beds comprising the Cretaceous formation of New Jersey, which had been communicated to him by Prof. Geo. H. Cook for comparison, to-wit:

8. Greensand, Third or Upper Bed. [Probably of Eocene Age.]

This bed admits of a triple division, the central portion is nearly destitute of fossils, while those of the upper and lower divisions are mostly dissimilar.

7. Quartzose Sand, resembling Beach Sand.

This bed is (so far as known), quite destitute of fossils.

Equivalent to Nos. 4 and 5 of the Nebraska Section.

6. Greensand, Second Bed.

(*a*) Yellow limestone of Timber Creek. Characterized by *Eschara digitata*, *Montivaltia atlantica*, *Nucleolites crucifer*, *Ananchytes cinctus*, *A. fimbriatus*, Morton.

(*b*) A bed of nearly unchanged shells. Among the characteristic fossils of this bed are *Gryphæa vomer*, *G. convexa*, and *Terebratula harlani.*

(*c*) Greensand, etc.

Cucullæa vulgaris is the most characteristic fossil of the lower division.

5. Quartzose Sand highly Ferruginous throughout, and Argillaceous in its upper parts.

This rock is sometimes indurated or cemented by oxyd of iron. *Exogyra costata*, *Ostrea larva*, *Belemnitella mucronata*, *Pecten* (*Neithea*) *quinque-costatus ;* and many other fossils mostly in the condition of casts of the interior, or impressions of the exterior.

4. Greensand, First or Lower Bed.

Several subdivisions may be recognized depending on the character of the marl, etc. *Exogyra costata*, *Ostrea larva*, *Belemnitella mucronata*, *Terebratula sayi*, (*Gryphæa convexa* and *G. mutabilis*), *Ostrea vesicularis.*

3. Dark Colored Clay, containing Greensand in Irregular Stripes and Spots.

Ammonites delawarensis, *A. placenta*, *A. conradi*, *Baculites ovatus*, casts of Cardium.

2. Dark Colored Clay. [Position of beds Nos. 2 and 3 of the Nebraska section.]

At the present time the evidence tends to show that No. 1 of the Nebraska section is represented by Nos. 1 and 2, and that Nos. 2 and 3 of the Nebraska section are wanting, and would find a place between Nos. 2 and 3 of this section if existing.

This bed contains large quantities of fossil wood (no animal remains are known to occur in it).

1. Fire Clay and Potter's Clay.

This bed contains fossil wood, and numerous impressions of leaves; but no animal remains.

In making the comparison of the strata he placed a large part of the Cretaceous fossils of the boundary survey in the same parallel with beds Nos. 2 and 3 of the Nebraska section, and below those beds in New Jersey and Alabama, which contain *Baculites ovatus*, *Nautilus dekayi* and *Ammonites placenta*. He described from Leon Springs, *Pyrina parryi*.

Prof. T. A. Conrad described, from between El Paso and Frontera, *Turbinolia texana*, *Cucullæa terminalis*, *Arca subelongata*, *Cardium mediale*, *Cytherea texana*, *Ostrea vellicata*, *Nodosaria texana*; from Leon Springs, *Trigonia texana*, *Protocardia filosa*, *Cardita eminula*, *Lima leonensis*, *Cytherea leonensis*, *Ammonites geniculatus*, *A. leonensis*, *Capsa texana*, *Terebratula leonensis*, *Turritella leonensis;* from Rio San Pedro, *Cardium congestum*, *Natica collina*, *N. texana*, *Rostellaria collina*, *Buccinopsis parryi;* from Dry creek, Mexico, *Ostrea cortex*, *O. multilirata;* from Turkey creek, Leon and Eagle Pass roads, *Pholadomya texana;* from Jacun, three miles below Laredo, *Ostrea robusta*, *Ammonites pleurisepta;* from other places, *Corbula occidentalis*, *Inoceramus texanus*, *Astarte texana*, *Plicatula incongrua*, *Ostrea bella*, *O. lugubris*, *Turritella planilateris*, *Nerinea schotti*, and *Cardita subtetrica*.

Evans and Shumard* described, from Nebraska, *Avicula nebrascana*, *Limopsis striato-punctata*, *Cardium subquadratum*, and *C. rarum*, now *Protocardia subquadrata*, and *P. rara*, *Arca sulcatina*, now *Nemodon sulcatinus*, *Leda fibrosa*, now *Neæra fibrosa*, *Mytilus meeki*, now *Volsella meeki*, *Ostrea subtrigonalis*, *Pleurotoma minor*, *Fusus nebrascensis*, *Turritella multilineata*, *Rostellaria americana*, now *Anchura americana*, and *Ammonites galpini*.

Meek and Hayden† described, from the Great Bend of the Missouri,

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* Trans. St. Louis Acad. Sci., vol. 1.

† Proc. Acad. Nat. Sci., vol. 9.

and other places in Nebraska (Fort Pierre Group), *Ptychoceras mortoni*, *Fusus subturritus*, now *Pyrifusus subturritus*, *F. intertextus*, now *P. intertextus*, *Xylophaga elegantula*, now *Turnus elegantulus*, *X. stimpsoni*, now *T. stimpsoni;* from (Fox Hills Group), near the mouth of Heart river, *Fusus vaughni*; and from other parts of Nebraska, *Fusus* (?) *scarboroughi*, now *Fasciolaria scarboroughi*, *Pholadomya subventricosa*, *Cyprina cordata*, now *Sphæriola* (?) *cordata*, *C. compressa*, *C. subtumida*, *C. ovata*, *Pectunculus subimbricatus*, now *Axinæa subimbricata*, *Ostrea translucida*, *Hemiaster humphreysanus*; from the mouth of Judith river, *Vitrina obliqua*, *Planorbis amplexus*, *Helix occidentalis*, now *Hyalina occidentalis*, *H. vitrinoides*, now *H. vetusta*, *Melania omitta*, now *Goniobasis omitta*, *M. subtortuosa*, now *G. subtortuosa*, *M. sublævis*, now *G. sublævis*, *M. invenusta*, now *G. invenusta*, *Unio danai*, *U. deweyanus*, *U. subspatulatus*, *Ostræa glabra;* from the Fort Union Group, Lignite beds at Fort Berthold on the Missouri river, *Planorbis fragilis*, now *P. planoconvexus*, *Melania tenuicarinata*, now *Goniobasis tenuicarinata*, *M. warrenana*, now *Hydrobia warrenana;* from the Fort Benton Group, at the mouth of Vermilion river, *Serpula tenuicincta;* from the Dakota Group, near the mouth of Vermilion river, *Solen dakotensis*, now *Phorella dakotensis*, and *Cyprina arenaria*, now *Cyrena arenaria.*

The rocks* of the Lower Cretaceous, in Mississippi, consist principally of stratified sand, mixed with a large proportion of silicate of iron or glauconite, which imparts to it a greenish color of different hues, and has given origin to the very appropriate name of greensand. The indurated greensand is generally full of fossils. It is exposed in the western part of Tishamingo, eastern part of Tippah, northwestern part of Itawamba, northeastern part of Pontotoc, and northeastern part of Lowndes county.

The Upper Cretaceous has sometimes been called the rotten limestone, and occupies a larger area than the lower division. It occupies part of Kemper, Noxubee, Lowndes, Ocktibbeha, Chickasaw, Monroe, Pontotoc and Itawamba counties. This division is also highly fossiliferous where well exposed. The estimated thickness of the whole is placed at from 1,200 to 1,500 feet.

Dr Leidy† described, from Columbus, Miss., *Hadrodus priscus;* from Nebraska, *Phasganodus dirus*, and from the greensand of New Jersey, *Pycnodus robustus.*

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* Geo. of Miss.
† Proc. Acad. Nat. Sci., vol. 9.

In 1858, Dr. Geo. G. Shumard* described the Cretaceous rocks near the mouth of Delaware Creek, on the Rio Pecos, in New Mexico, where he found a thickness of 960 feet. The first 100 feet consists usually of a hard limestone, of a light cream color and earthy texture, and contains numerous spheroidal cavities, from a fourth to a half an inch in diameter, which are sometimes partially filled with loose, ferruginous earth. In other places it is softer and lighter colored, resembling impure chalk. Beneath this limestone, deposits of gypsum, clay and sandstone occur. In some places the strata are much disturbed, and are found dipping in opposite directions, at angles of 40° or 50°. He also referred to the Cretaceous† certain strata in the bluffs of the Mississippi, above Commerce, Missouri, having a thickness of 158 feet, but no fossils were obtained.

The Cretaceous rocks‡ occupy a belt across the State of Alabama, from 50 to 100 miles in width. The counties, either in whole or in part, exposing these rocks on the surface, are Barbour, Russell, Pike, Macon, Montgomery, Butler, Lowndes, Autauga, Wilcox, Dallas, Perry, Marengo, Greene, Choctaw, Sumpter and Pickens.

T. A. Conrad§ described, from Tippah county, Mississippi, *Pholadomya tippana, Periploma applicata, Siliquaria biplicata*, now *Leptosolen biplicatus, Legumen ellipticus, L. appressus, Dosinia densata, Meretrix tippana*, now *Aphrodina tippana, Papyridea bella, Cardium ripleyense, C. spillmani, C. tippanum, Opis bella, O. bicarinata, Tellina ripleyana, Nucula percrassa, Cibota lintea, Cucullæa capax, C. tippana*, now *Idonearca tippana, Dreissena tippana, Pinna laquata, Gervillia ensiformis, Lima acutilineata, Inoceramus argenteus, I. costellatus, Ostrea confragosa, O. peculiaris, O. denticulifera, Exogyra interrupta, Pulvinites argentea, Anomia sellæformis, Strombus densatus*, now *Pugnellus densatus, Aporrhais decemlirata*, now *Anchura decemlirata, Harpago tippanus*, now *Pterocerella tippana, Rimella curvilirata, Conus canalis, Drillia tippana, D. novemcostata, Turris ripleyana, Fusus novemliratus, F. bellaliratus; Pyrifusus subdensatus, Ficus octoliratus, Rapa supraplicata, Volutilithes cretacea*, now *Volutomorpha cretacea, Chemnitzia distans, C. interrupta, Trichotropis cancellaria, Turritella altilis, T. tippana, Lunatia rectilabrum, Solidulus linteus, Bulliopsis cretacea, Baculites spillmani, B. tippaensis, Scaphites iris, and Cytherina tippana.*

Meek and Hayden‖ described, from (now the Fox Hills Group) Long

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* Trans. St. Louis Acad. Sci. vol. 1.

† Proc. Am. Ass. Ad. Sci.

‡ Geo. of Ala., 1858.

§ Jour. Acad. Nat. Sci., 2d ser. vol. 3.

‖ Proc. Acad. Nat. Sci.

Lake, Nebraska, *Corbula inornata*, *Pholas cuneata*, now *Martisia cuneata* and *Actæon attenuata.*

From (now the Fort Pierre Group) near Fort Clark, *Teredo globosa*, *Helicoceras tortum*, now *Heteroceras tortum*, *Turrilites cochleatus*, now *Heteroceras cochleatum*, *H. tenuicostatum*, *Turrilites umbilicatus*, now *H. umbilicatum*, and *Ancyloceras uncum.*

From (now the Fort Benton Group) Fort Benton, on the Upper Missouri, *Inoceramus umbonatus* now *Volviceramus umbonatus*, and from the Black Hills, *Scaphites larvæformis.*

Dr. Leidy described, from the marl of Haddonfield, Camden county, New Jersey, *Hadrosaurus foulki.*

F. B. Meek* described, from Vancouver's Island, *Nucula traskana*, *Arca æquilateralis*, *A. vancouverensis*, *Cardium scitulum*, *Pholadomya borealis*, *P. subelongata*, *Trigonia evansana*, *Thracia occidentalis*, *T. subtruncata*, *Dentalium nanaimoense*, and *Ammonites ramosus.*

Dr. B. F. Shumard† described, from the same island, *Inoceramus vancouverensis*, *Pinna calamitoides*, and *Pyrula glabra.*

Prof. E. Emmons‡ described, from the Greensand of North Carolina, *Sphenodus rectidens*, and *Belemnitella compressa.*

Prof. Oswald Heer,§ of Zurich, Switzerland, described, from Nebraska, *Liriodendron meeki*, *Sapotacites haydeni*, *Leguminosites marcouanus*, now *Bumelia marcouana*, *Populus cyclophylla*, now *Cissites cyclophylla*, *Phyllites obcordatus*, and *P. obtusilobatus.*

In 1859, Prof. Henry Y. Hind‖ found the Cretaceous rocks in position on the Little Souris River, in longitude 100° 30′ W., and on the South Branch of the Saskatchewan, in longitude 106° 35′ W., and between these widely separated points in many places on the Assiniboine, the Qu'Appelle, and their affluents. Fifteen miles from the mouth of the Little Souris, the rocks consist of a very fissile, dark blue argillaceous shale, holding numerous concretions, containing a large per cent. age of iron. This exposure is 70 feet thick, and the layers are perfectly horizontal. The whole is supposed to be of the age of the Fort Pierre Group. The Cretaceous of this latitude appears to repose directly upon the Devonian, as the former is found undisturbed and nearly horizontal at altitudes from 400 to 600 feet above exposures of Devonian age, recognized *in situ* 30 miles to the east.

Prof. F. B. Meek¶‖ described, from the Little Souris River, *Anomia flemingi*, *Inoceramus canadensis*, *Leda hindi*, now *Nucalana hindi*, and

* Trans. Alb. Inst., vol. 4. † Trans. St. Louis Acad. Sci., vol. 1.
‡ Geo. Sur. N. Carolina. § Proc. Acad. Nat. Sci.
‖ Assiniboine and Saskatchewan Expl. Exped.
¶ Rep. on Assiniboine and Saskatchewan Expl. Exped.

from the valley of Mackenzie's River, *Ammonites, barnstoni;* and *A. billingsi.*

Prof. Leo. Lesquereux* described, from Vancouver's Island, and Bellingham Bay, *Populus rhomboidea, Salix islandicus, Quercus benzoin, Q. multinervis, Q. evansi, Q. gaudini, Q. platinervis, Planera dubia, Cinnamomum heeri,* now *Daphnogene heeri, Persoonia oviformis,* and *Diospyros lancifolia.*

In 1860, Dr. B. F. Shumard† subdivided the Cretaceous strata of Texas in descending order, as follows: 1. Caprina limestone, having a thickness of 60 feet, and consisting of a yellowish white limestone, usually massive, sometimes of a finely granular structure, and sometimes made up of rather coarse, subcrystalline grains, cemented with a chalky paste. It has an extended geographical range. 2d. The Comanche Peak Group, having a thickness of 300 to 400 feet, and made up of soft, yellowish and whitish chalky limestone, and buff and cream-colored limestones of greater or less compactness, being highly fossiliferous, and having a great geographical extension. 3. The Austin limestone and fish bed, having a thickness from 100 to 120 feet. The Austin limestone consists of cream-colored and bluish earthy limestones, and the fish beds of shaly layers of dark-bluish-gray calcareous sandstone. This is supposed to represent Nos. 4 and 5 of the Nebraska section, by Meek & Hayden. 4. Exogyra arietina marl, having a thickness of 60 feet, and consisting of an indurated blue and yellow marl with occasional bands of gray limestone, and thin seams of selenite interstratified. 5. Washita limestone, having a thickness from 100 to 120 feet, a wide geographical range, and consisting of white, yellow, gray and blue limestones, some of which are moderately hard, and others disintegrate rapidly. This is supposed to be parallel with the lower part of No. 3 of the Nebraska section, by Meek and Hayden. 6. Blue marl, having a thickness of 50 feet, and consisting of an indurated arenaceous marl, of a schistose structure, with small nodules of iron pyrites and irregular masses of lignite disseminated through it. It is not observed south of Grayson county, and is supposed to correspond with No 2 of the Nebraska section. 7. Caprotina limestone, having a thickness of 55 feet, and forming the basis of what is called the Upper Cretaceous Group. It is composed of light gray and yellowish gray earthy limestone, with intercalated bands of yellow marl and sometimes flint, and is exposed at the base of the hills near Comanche Peak, and underlying the Washita limestone near the Colo-

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* Amer. Jour. Sci. and Arts, 2d Series, vol 27.
† Trans. St. Louis Acad. Sci., vol. 1.

rado, at the foot of Mt. Bonnell. 8. The Arenaceous Group and fish bed, having a thickness of 80 feet, and consisting of light yellow and blue sandstone, and beds of sandy clay, with crystals of selenite and some lignite. This is supposed to be the same as B, C and D of the Pyramid Mount Section of Prof. Marcou, and by him referred to the Jurassic period, and to be equivalent to No. 1 of the Nebraska Section. 9. Marly Clay or Red River Group, having a thickness of 150 feet, and supposed to represent the lower part of the Pyramid Mt. Section, which Prof. Marcou referred to the Trias.

He described *Nautilus texanus*, *Ammonites inæquiplicatus*, *A. swallovi*, *A. meekanus*, *A. graysonensis*, *A. brazoensis*, *Scaphites vermiculus*, *Ancyloceras annulatum*, *Baculites gracilis*, *Cerithium bosquense*, *Phasianella perovata*, *Avellana texana*, *Natica acutispira*, *Neritopsis biangulatus*, *Venus sublamellosus*, *Cardium choctawense*, now *Protocardia choctawensis*, *C. coloradoense*, *C. brazoense*, now *Protocardia brazoensis*, *Cytherea lamarensis*, now *Dione lamarensis*, *Tapes hilgardi*, *Arca proutana*, *Lucina sublenticularis*, *Nucula haydeni*, *N. serrata*, *Corbula graysonensis*, *C. tuomeyi*, *Pachymya austinensis*, *Panopœa newberryi*, *P. subparallela*, *Inoceramus capulus*, *Gervillia gregaria*, *Janira wrighti*, *Ostrea belliplicata*, *O. quadriplicata*, *Cidaris hemigranosus*.

Wm. M. Gabb* described, from Prairie Bluff, Alabama, *Chemnitzia meekana*, *Straparollus subplanus*, *Sconsia alabamensis*, *Cancellaria alabamensis*, now *Turbinopsis alabamensis*, and *Bulla macrostoma*; from the marl of New Jersey, *Actæonia naticoides*, now *Cinulia naticoides*, *Phasianella punctata*, *Volutilithes biplicata*, now *Rostellites biplicatus*, *V. bella*, *now R. bellus*, *V. nasuta*, now *R. nasutus*, *V. conradi*, now *R. conradi*, *Fusus retifer*, *Rapa elevata*, *Morea naticella*, *Bulla recta*, *Mysia gibbosa*, *Dione delawarensis*, *Crassatella delawarensis*, *C. monmouthensis*, *Cardita subquadrata*, *Leda pinniformis*, now *Nuculana pinniformis*, *L. protexta*, now *N. protexta*, *Cultellus cretaceus*, *Pecten burlingtonensis*; from Tennessee, *Volutilithes saffordi*, and *Cardium abruptum*; from New Jersey, *Actæonina biplicata*, now *Solidula biplicata*, *Solarium abyssinus*, now *Margaritella abyssinus*, *Volutilithes abbotti*, *Turbinella subconica*, *T. parva*, *Cancellaria septemlirata*, *Purpuroidea dubia*, *Fusus trivolvis*, *Rapa pyruloidea*, *Pleurotoma mullicaensis*, *Arca quindecemradiata*, *Cibota multiradiata*, and *Leda angulata*, now *Nuculana angulata*, *Desmatocium trilobatum*, and from Eufala, Alabama, *Cassidulus micrococcus*.

[To be Continued.]

* Jour. Acad. Nat. Sci. 2d. Ser., vol. 4.

SOME NOTES ON AMERICAN LAND SHELLS.

By A. G. Wetherby,

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H. (*Stenotrema*) *hirsuta*, Say.—This abundant and well-known species exhibits two very remarkable varieties in Kentucky and Tennessee. The one is a small, thick-shelled, globular variety, which wants the hirsute covering of the typical specimens of the species, and which inhabits the dry ridges and plateaus of the carboniferous formation known as the "Pine Barrens." Here it lives under logs in the dryest situations, in company with *H.* (*Patula*) *perspectiva*, Say, and *H.* (*Zonites*) *interna*, Say. In the same region, and in similar stations, I have found but two other species, the *H.* (*Zonites*) *chersina*, Say, very rare, and the *H.* (*Zonites*) *intertexta*, Binney. None of the shells associated with it seem to have undergone much, if any, variation from the normal type, a fact of peculiar significance.

The other variety is almost the opposite of the above. It is much larger than the type, has the spire either very much elevated and conical, or very much flattened; the shell is much thinner when compared with the size than in the previous variety, and the epidermis is hirsute. The periphery of the specimens with the depressed spire is often carinate. In size it equals the largest specimens of *H.* (*Stenotrema*) *stenotrema*, for which this variety has often been taken, and which name I have found it bearing in various collections.

As I had always found these varieties by themselves, previous to last summer, the small one in the regions above mentioned, and the larger in the subcarboniferous limestone belt surrounding it, I had arrived at the too hasty conclusion that they were varieties due to station. During the past year, however, I found the two forms together in Pulaski county, Kentucky, even under the same logs. It now becomes clear that we must look elsewhere for the causes of these variations.

H. (*Stenotrema*) *edvardsi*, Bland.—This species was described by Mr. Bland, in 1858, the type having been collected by Mr. W. H. Edwards, the well-known entomologist, in Fayette and Green Brier counties of Virginia. The shell escaped the notice of collectors from that time until I found it in Laurel and Whitley counties, Kentucky, in August of 1875. Since then I have found it to be widely distributed in the dry oak forests between King's Mountain, Kentucky, on the Cincin-

nati Southern Railroad, and Elk river in Franklin county, Tennessee. It has not yet been found by me in the Central Valley of Tennessee, but it reappears again in the dry forests west of the valley in Hardin and Wayne counties.

In *Terrestrial Mollusks*, vol. v., in remarks under this species, it is asserted that "in *barbigera* the attached hair-like epidermidal processes are produced, at the sutures and carina, into cilia, which are entirely wanting in this species." This is often the case in old or poorly preserved specimens, but in good, mature, well conditioned examples, the fringes of the sutures and carina are as well shown as in *H. barbigera*. Not only so, but in collecting large numbers of the latter species, we find comparatively few so well preserved as to show the fringe around the carina, which is characteristic not only of these two species, but also of the *H. spinosa* and *H. edgariana*. A variety of this shell, inhabiting open, wooded pastures, near Somerset, Kentucky, is much larger than the normal type, and bears a very close resemblance to *H. barbigera*, at first glance.

H. (*Stenotrema*) *stenotrema*, Say.—This species has the same southern distribution as the last, and a wider one to the north and west. A variety occurs on the Cumberland Plateau, in Franklin county, Tennessee, which has the spire unusually elevated, and the base abnormally convex below. The typical form more nearly resembles that of the large variety of *H. hirsuta* mentioned above. The two forms approach each other so closely that they have been confounded. Mr. Binney, in *Terrestrial Mollusks*, vol. v., quoted above, says, "the form of the parietal tooth, however, varies in *hirsuta*, from which this species can chiefly, if indeed not alone, be distinguished by the size and position of the notch."

These two species, *hirsuta* and *stenotrema*, with their varieties, form a series of differentiations that would be reduced to one species by the same treatment which has brought other shells less closely united under the same synonymy.

H. (*Stenotrema*) *edgariana*, Lea.—This rare species occurs in Tennessee, not far from the line of the Cincinnati Southern Railroad, and the locality furnishes specimens in a most beautiful state of preservation. The shell differs from the *H. spinosa*, Lea, with which it has been confounded, in the following prominent characters. It is smaller, more solid, with a much more elevated spire, and more convex base. The whorls are more rounded, and there is no evidence of the peripheral overlap which, in the *H. spinosa*, gives the edge of each whorl, in perfect specimens, a transparent, corneous-looking margin,

overlying the sutures. Instead, the latter are impressed and well defined. The lower surface is marked with elongated pits or scars, with their longer axis radiating from the base of the columellar depression, which are entirely wanting in *H. spinosa.*

The latter has the under surface thickly crowded with plainly seen microscopic revolving lines. They exist, also, on the *H. edgariana*, but are much smaller, and not easily seen unless with a good magnifier. The upper surface of the shells is very much alike, except that the prostrate hairs are more crowded in *edgariana.* The animal is black, very active, and carries the shell balanced horizontally. Notwithstanding the diverse characters of these species, they seem to be as closely united as the typical *H.* (*Patula*) *alternata*, and *H.* (*Patula*) *mordax*, inhabiting the same region, and in the same stations, and which have been made synonymous.

H. (*Stenotrema*) *labrosa*, Bland.—I have received this rare species from two localities, Springfield, Mo., and Hematite, Mo. At the former locality it was associated with the equally rare *H.* (*Polygyra*) *jacksoni*, Bland; at the latter with the *H.* (*Polygyra*) *dorfeuilliana*, Lea, a species which is far from common. The force of the remark under this species in *Terrestrial Mollusks*, vol. v., is hardly apparent, "the thickened and reflected peristome, and deep wide notch, sufficiently distinguish *labrosa* from *edgariana*," as there is no reason whatever for confounding these species. This shell belongs to that division of the group represented by *stenotrema* and *hirsuta*, and not to that formed by *spinosa* and *edgariana.* The shells brought together by Mr. Binney, in the volume above referred to, under the genus *Stenotrema* of Rafinesque, are readily arranged in four groups. First, the group including *edvardsi* and *barbigera* characterized by the extraordinary development of the epidermal hairs. Second, that formed by *spinosa* and *edgariana* equally well characterized by the sharp periphery of the body-whorl, and the prostrate epidermal hairs. Third, the group containing *hirsuta*, *stenotrema*, *labrosa* and *maxillata*, in which the epidermal processes are shorter, and the surface is more tuberculate; and lastly the group containing *monodon*, *fraterna*, *leaii* and *germana.* Among themselves the species in each group are united more or less closely, those of the monodon group being usually regarded as varieties of that shell, with the exception of *H. germana*, which Mr. Binney finds to be related to *Stenotrema* by its jaw and dentition, and more nearly to *Mesodon* by its shell; a prominent character of which is the want of the internal tubercle. The writer may here record his opinion, that *H. leaii* is also a valid species if other species

are to be left to stand on characters which seem to be far less well defined.

The *hirsuta* group is next in this regard, and when the varieties of *hirsuta* and *stenotrema*, above mentioned, are taken into consideration, the blending of the species into varietal forms is pretty well assured in one or two cases. It seems that the *edvardsi* group and the *spinosa* group, of but two species each, though well enough characterized to be distinguished as separate divisions of this genus, may be united with the *hirsuta* group by several characters of greater or less importance. It is not pretended that this grouping is of any systemic value, whatever; but it will serve to call attention to the relations which the species of this singular genus bear to each other, and to their nearest allies in other genera, the genus gradually shading into Mesodon as represented by *H. columbiana*, Lea, through *H. germana*, Gould.

H. (Patula) cumberlandiana, Lea.—I collected this beautiful species during August of 1878, in Franklin county, Tenn. It inhabits the lower slopes of the Sewanee Plateau, living in crevices of the subcarboniferous limestone. In places where the rocks have become sep. arated, so that isolated masses lie on the mountain side, this curious mollusk has taken up its abode between two layers of the rock. It often happened that the upper layer was thin, and the crevice thoroughly dried out; but in such apparently unsatisfactory places the shells were found, the animal having closed the aperture with a transparent but dense epiphragm. The locality is a small one, the whole area within which it is possible to find the species being but a few hundred square yards. As multitudes of the young shells are found dead, and comparatively so few either of young or adult living, the fair inference is that this rare species will at no distant day become extinct in this place. A locality, of late years, unidentified, is Jasper, Tenn. I spent some time in Jasper during August of 1878, but no sign of this shell was discovered. In Mr. Binney's note under this species, in *Terrestrial Mollusks*, vol. v., he says, "*Helicina orbiculata*, and a few ribbed *alternata* found with them." The "variety" of *H. alternata*, here mentioned, can not be the *H. mordax*, Shuttleworth, which does not occur at this locality. I found the following species associated with the *cumberlandiana* in the crevices; *H. spinosa*, *H. stenotrema*, *H. hazardi*, *H. alternata;* and numbers of the small southern scorpion, *Buthus carolinianus*, Beauvois. The true *H. mordax*, of which I have types kindly furnished me by Mr. Bland, is a very different shell from the varieties between it and the typical *alternata*, and is truly a rare species.

H. (*Triodopsis*) *copei*, Wetherby.—This species, of which I published a description in the *American Naturalist* for March, 1878, with good figures, has since been recognized as distinct, both by Mr. Binney and Mr. Bland, although it receives no mention by Mr. Binney in *Terrestrial Mollusks*, vol. v., this volume being issued in July, 1878, before he had seen either the types or the description.

The shell belongs to that division of the genus *Triodopsis*, of which the *H. vultuosa*, Gould, is the type. It is a well-marked species, and need only be compared with *H. vultuosa*, and that form published by Mr. Mazye, as *H. henriettæ*, and which Mr. Binney regards as a variety of *vultuosa*. From both it differs in the form of the parietal tooth, as well as in other plain characters. It was associated with the following species, in the pine forests and oak hammocks, twenty miles north of Beaumont, Texas. *H. intertexta*, Binn., *H. demissa*, Binn., a carinate variety; *H. monodon*, Rackett, a peculiar, very elevated form, which I have never seen from any other locality; *H. thyroides*, Say; a variety with the umbilicus closed, and affording many specimens with an extraordinary elevation of the spire, and of a beautiful red color; *H. vultuosa*, Gould, "typical" (Bland), and *H. arborea*, Say. With these was found the *Helicina tropica*, Jan, in great numbers. It is a fact, worthy the attention of collectors, that it is not worth while to search under or about *pine logs* for snails. At this locality, where any fragment of bark, any chip, or any log of other timber was found to be inhabited by the mollusks, the pine logs were invariably barren; and such I have ever observed to be the case in Tennessee, Kentucky and North Carolina; and the rarity of land shells in forests, almost or exclusively pine, is a fact well known.

In this connection it may not be out of place to state that the collector who has a full series of all the North American species of *Triodopsis*, even if without the many intervening varieties from differing stations, will reach the conclusion that many of the so-called species are sub-species or varieties, and a full description of these varieties and their comparison with the type, as the Marchesa Paulucci has done in her beautiful work, *Fauna Malacologica Della Calabria*, Firenze, 1880, "is a consummation devoutly to be wished." In this invaluable contribution to the malacology of southern Europe, the illustrious author has devoted four elegant plates, of twenty-five figures each, or one hundred figures in all, to the illustration of the well-known *Helix* (*Campylæa*) *planospira*, Lam., and its varieties, the species *pubescens*, *casertana*, *depilata*, *setulosa*, *calabrica*, *neapolitana* and *cassinensis* which have been founded upon it, and which are here

reduced to synonyms. Varieties are figured of the well known *H. olivieri*, Fer., *H. subprofuga*, Stabile, *H. pyramidata*, Drap., *H. muralis*, Müll., *Clausilia kobeltiana*, Küster, and many other species. Such a treatment of the various genera of our North American snails would be the most important contribution to our conchology that could now be made; and the material for doing it is abundant. It is to be hoped that some competent person will, ere long, undertake the work.

Glandina (Oleacina) decussata, Deshayes, var. (Bland, Binney, Tryon).—Having lately received a number of specimens of this exceedingly rare species, as thus identified, from western Texas, embracing specimens of every age, I wish to put upon record my opinion that the high authorities here quoted are no doubt in error in this determination, or that the figure in pl. lxi., *Terrestrial Mollusks*, vol. v., originally called by Dr. Binney, "*Glandina truncata*, Say, var.," is much out of the way. The spire of my specimens is much less acute, and more like that of *G. texasiana*. The "revolving lines," which are so plainly shown in Mr. Binney's figure, are invisible on my specimens without the aid of a magnifier. *Glandina decussata* is described as having seven or eight whorls, while the largest specimens of the present form have but six. If a variety of *Glandina decussata*, it is certainly a very distinct one. It is associated with *Holospira roemeri*, Pfr., a species equally rare, with a *Macroceramus*, which Mr. Bland refers, doubtfully, to *M. pontificus*, Gould; with a *Bulimulus*, of which only dead specimens were received, and which resembles in outline, very nearly, the *B. patriarcha*, W. G. Binney; with the *H. mooreana*, W. G. Binney, and *H. berlandieriana*, Moricand.

Holospira roemeri, Pfr.—This shell, very rare in collections, was received with the preceding. All the specimens were dead, but some were in a fair state of preservation, so as to indicate all the characters distinctly. It inhabits crevices of the rocks, and only comes out in rainy or damp warm weather. Judging from the number of dead specimens, it can not be scarce in the localities where it occurs.

Helix (Polygyra) espiloca, Ravenel.—I collected large numbers of this shell in December, 1878, at Orange, Texas, and Brashear City, Louisiana. Its station was under logs, bits of bark, boards, etc., and it had spread, at the latter locality, even into the yards of private residences, and under the plank sidewalks of the principal streets. The *H. pulchella*, Müll., and *Pupa contracta*, Say, were found with it at Brashear.

Ariolimax columbiana, var. *hecoxi*.—I have received, at different

times, numerous specimens, at every stage of growth, of a large *Ariolimax*, found at Santa Cruz, California, by Miss Laura J. F. Hecox. The class in the University dissected numerous individuals, working out the genitalia in detail. The most casual examination showed that these organs did not agree with any of Mr. Binney's figures, from dissections of various west coast species, and Mr. Binney, after a careful examination of the specimens, at different ages, with a study of the genitalia, unhesitatingly pronounces it a new species. For the present, however, I prefer to give it only the variety name above assigned, until I have the opportunity of making a careful study of undoubted specimens of *A. columbiana*, and a systematic comparison of these parts. It may be the form referred to by Dr. Cooper as possibly new, in his review of Mr. Binney's *Terrestrial Mollusks*, vol. v., *Proc. Phil. Soc.*, 1879.

Associated with it is a small, brown, slender species of *Prophysaon*, which I have not been able to identify from alcoholic examples. Living specimens of this *Ariolimax* may be seen in the Aquarium and Museum of Natural History, at the Exposition Building, one of which, an adult, measures fully nine inches in length, when extended.

H. (*Aglaja*) *fidelis*, Gray.—I have received from Washington Territory, a very large and fine variety of this species, which is entirely white, save a dusky area around the umbilical region. In every other particular, it accords with the magnificent typical specimens found there. As I had noticed upon living examples of this species, and of the *H. infumata*, particles of pitch or resin adhering to the shells, I naturally concluded that these mollusks inhabited the pine trees. In answer to my inquiry as to the station and habit, my friend replies: "*H. fidelis* is a tree-climber, ascending the trees to a height of 30 or 40 feet. We capture them in May and June when they are depositing their eggs in the damp moss at the roots of trees and other favorable places." As neither Mr. Binney nor Mr. Bland had seen the albino variety of this shell, until I sent it to them, and as it may be new to other collectors, I put it upon record in this manner.

H. (*Zonites*) *rugeli*, W. G. Binney.—Mr. Binney has recently described this species from specimens collected on Roan mountain, Mitchell county, N. C., see *Annals N. Y. Acad. Sci.*, vol. i., No. 11. Having received types of the species, both from Mr. Binney and from Mr. Bland, I wish to put upon record its occurrence in the Ocoee District of southeastern Tenn., between Cleveland, Tenn., and the Ducktown copper mines, where I collected it in July, 1878, referring it to the globular variety of *H. inornata*, figured by Mr. Binney in *Terres-*

trial Mollusks, vol. v., p. 109. The shell is, however, entirely distinct from *inornata*, and seems to connect the latter with *lævigata*, Pfr., or to stand in such relation to the latter and *inornata*, as *friabilis* does to *fuliginosa*, and the typical *caprodes.*

Associated with this shell in the Ocoee region was the *H.* (*Mesodon major,* Binney, typical, and a very rare species of *Helicodiscus*, as yet undescribed.

It is certain that a careful search of this interesting region would add largely to our knowledge of the varietal forms, which seem to originate, as I have before attempted to show,* in the mountain regions, and to spread thence over the valleys, mingling with varieties and species found there, or perhaps themselves peopling these regions with their descendants at first. At all events, the slightest study of the mountain fauna shows us that there are the greatest deviations from what we have been taught to regard as types, but probably only because discovery began with derivatives found in the valleys rather than with the true types found in the mountains. So rapidly, however, are discoveries being made, and so thoroughly are these mountain fastnesses being explored, that they must soon yield their closest secrets to the host of untiring workers now invading their hitherto untrodden domains.

ARCHÆOLOGICAL EXPLORATIONS NEAR MADISONVILLE, OHIO.

The following paper, containing an account of archæological investigations, conducted under the direction of the Literary and Scientific Society of Madisonville, Ohio, has been chiefly prepared by Mr. Charles F. Low, at the request of a publishing committee appointed by that Society. It is designed to be one of a series of papers on the same subject, which will comprise a chronological record of facts as they have been observed, laying aside for the present any special attempt at literary merit or speculative deduction.

JOSEPH COX, Sr.
CHARLES F. LOW.
CHARLES L. METZ, M.D.
FRANK W. LANGDON.
Committee on Publication, L. & S. S. of M.

Madisonville, Hamilton Co., O., *March*, 1880.

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* This Journal, October, 1878.

The JOURNAL of this Society, for October, 1878 (Vol. I., No. 3), contains a contribution by Dr. Charles L. Metz, on the aboriginal remains in this vicinity, accompanied by a chart, on which the mounds and earthworks are designated by symbols, in accordance with the international code of MM. Mortillet and Chantre.*

The examination and exploration of these remains—which was begun by Dr. Metz, and a few other gentlemen, with a view of preserving as many of the relics as possible, and of making suitable record of all existing earthworks before they had been entirely destroyed by cultivation—was continued during the fall and winter of 1878, and several of the mounds located on the above-mentioned chart were opened and explored.

On Wednesday, Nov. 22, 1878, the mound known as the Spice Bush Mound (No. 5, Group A), was opened under the direction of Dr. Metz, in the following manner: A trench, about five feet in width, was commenced on the north side of the mound, and carried to the center; the mound had previously been disturbed by digging from the top, and it was reported that some relics and human bones had been taken out, but of these no definite information could be obtained.

The following sketch (fig. 1) will show the stratification of the mound, which is about $5\frac{1}{2}$ feet in height, and 100 feet in circumference:

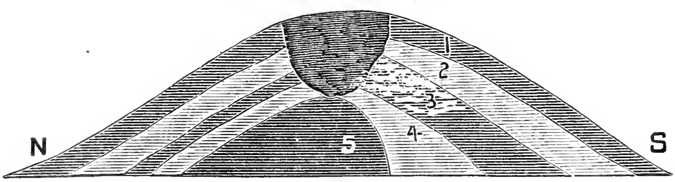

Fig. 1. Section of Mound No. 5, Group A.

No. 1 is a stratum of black leaf mold and gravelly clay, about 18 inches to two feet deep, and of the same general character as the surface soil in the immediate vicinity. No. 2 is an irregular layer of clay and sand. No. 3 is a bed of calcined limestone, about eight inches thick, with ashes and sand, and is confined to the southeastern quarter of the mound. No. 4 is a layer of pure sand; and No. 5, the probable center of the original, although not immediately in the center of the present mound, was composed of a peculiar compact, grayish earth, and presented an appearance very much like dry mortar.

During the progress of the work, five skeletons were found in an ex-

* *Vide* Smithsonian Report, 1875, and Circular in Reference to American Archæology, Smithsonian Misc. Coll. No. 316, 1878.

tended position, irregularly disposed, and so much decayed that none of the bones or crania could be preserved entire ; measurements were made by Dr. Metz before attempting to remove the skeletons, which were remarkable for their small size, averaging, as nearly as could be ascertained, but 5 feet 2 inches in length. The first skeleton was found at the base of the mound, quite near the natural surface; the second and third were about three feet higher on the slope, and covered with about 18 inches of earth; the fourth a short distance above and east of the third, the feet projecting into the trench referred to, and were followed out on the slope by a side trench about 18 inches deep. This skeleton was lying at an angle of 45°, with its head toward the base of the mound, and the lower limbs extended under a small dead tree. On removing this tree another skeleton was discovered and exhumed, and two small fragments of pottery were found near the cranium. Continuing the trench to the center, about three feet from the top of the mound, and imbedded in the grayish, mortar-like earth above referred to, a detached cranium was found. All the skeletons were undoubtedly intrusive burials, and appear to have been thrown upon the original mound irregularly, and covered with from 12 to 18 inches of earth taken from the immediate vicinity. Quite a number of fragments of burned limestone and broken boulders were scattered through the mound, and a few flint chips occasionally found.

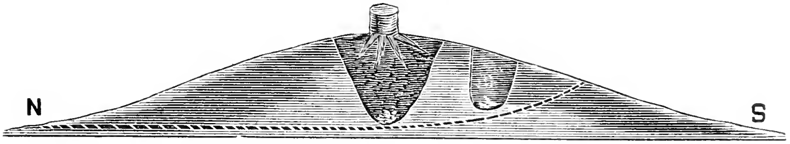

Fig. 2. Section of Mound No. 6, Group A.

On Nov. 28, another mound (No. 6, Group A), was opened, and the following account is quoted from the *American Naturalist*, for May, 1879, p. 328 : "The mound, which was opened under the direction of Dr. Charles L. Metz, of Madisonville, was composed of a light, sandy loam, like the surrounding soil, but had received an additional layer of yellow clay, ranging from six to twelve inches in thickness. Its measurements are approximately as follows: Circumference, 200 feet; height, 7 feet. It is situated on the 'second bottom,' or plateau, of the Little Miami River, about 150 feet above the water-line, and distant about one third of a mile from the river. A trench, four feet in width, and as deep apparently as the original surface, was carried to its center from opposite sides, but without at first finding anything to indicate

the former presence of man. Continuing a little deeper, however, almost directly in the center, there was found a small circumscribed deposit of ashes, mixed with fragments of charcoal and charred bones, about three or four handfuls in all; with these were mingled fragments of a human skull, in perfectly sound condition, so far as the action of fire was concerned, but very soft and friable through decay. They regained their hardness to some extent after being dried by exposure to the air."

The material excavated was all thrown back, and the mound restored as nearly as practicable to its original condition (fig. 2).

The absence of burned earth, broken boulders and stone implements is very remarkable, as the surface of the entire field is covered with these articles, and many fine implements of flint and stone have been picked up in the immediate vicinity of this mound.

On March 5, 1879, the mound No. 3, Group A, was opened by Dr. Metz. This mound was composed entirely of sand, and the soil in the immediate vicinity is of this character. At a depth of about four feet, in the center of the mound, a thick layer of charred wood and ashes, some broken boulders and fragments of pottery were found. On March 14, work was resumed on No. 5, Group A, and a trench commenced on the eastern slope of the mound. Numerous animal bones, several flint arrow points, and stone implements of the common form, but no human remains, were found. During the progress of work on this mound, the laborer, employed by Dr. Metz, had been prospecting, by digging holes in the surrounding forest, until finally, on the 20th of March, in the southwest section of the plateau, he came upon a human skeleton at a depth of about two feet ; these remains were, however, so much decayed that they could be preserved only in fragments. This was the initiatory step toward a most important archæological discovery, as further investigation has revealed the interesting fact that the entire plateau is the site of an ancient cemetery, from which have since been exhumed upward of four hundred skeletons of a pre-historic people, accompanied by numerous evidences of their handiwork, in the shape of flint and stone implements, pipes, pottery ware, charred matting and corn, tools and ornaments of bone, shell and copper, some of which are believed to be unique, all indicating an industrious people, who lived in large communities, and obtained their support by cultivating the soil, as well as by fishing and hunting.

A brief, preliminary sketch of the discovery was contributed to Professor Short's recent work, entitled *The North Americans of Antiquity*,

where the locality is described as follows:—"This cemetery, which is distant about one and one half miles southeast from Madisonville, occupies the western extremity of an elevated plateau overlooking the Little Miami River, and situated from eighty to one hundred feet above the water-line. It is bounded on the south by the river 'bottom;' on the north and west by a deep ravine, through which flows a small stream known as Whisky Run; on the east the plateau slopes gradually up to the general level of the surrounding country, of which it is in fact a continuation or spur, its character of an elevated plateau being derived from its position between the eroded river valley and the deep ravine above referred to. The precipitous but well-wooded bluff which forms the southern limit of this plateau, extends eastward, facing the river, for perhaps half a mile; and distributed along its edge are a number of mounds and other earthworks; at its base are the Cincinnati & Eastern and Little Miami Railways, the nearest station being Batavia Junction, distant about half a mile east of the cemetery. The original forest still covers the site of the cemetery, and measurements of some of the principal trees are recorded by Dr. Metz, in his paper before mentioned, as follows: a walnut, 15½ feet in circumference; an oak, 12 feet; a maple, 9½ feet; an elm, 12 feet. The locality has long been known to local collectors and others interested in archæological matters, as the 'Pottery Field,' so called on account of the numerous fragments of earthen ware strewn over the surface; and it was until recently supposed to be a place where the manufacture of pottery had been carried on by the ancient inhabitants of the valley, the fragments found being considered the *debris*. A few scattered human remains had also been found in the adjoining ravines, but it was not until some time in March, 1879, that its true character and extent as a cemetery were brought to light."*

The particulars of the discovery, by the man in Dr. Metz's employ, have been already referred to above.

On Friday, March 21, the excavation begun on the previous day was continued, and a skeleton in a horizontal position, with its head to the south, was exhumed. This appeared to be the remains of a female of large size (5 feet 10 inches). Near the left hip was deposited a large earthen vessel, capacity about one gallon; unfortunately this vessel was broken by the spade and thrown out of the trench, but most of the fragments were recovered. Near the head, four hollow cylinders or beads of polished bone, two to four inches in length, and

* "North Americans of Antiquity," by J. T. Short, Harper & Bros., N. Y., 1879, pp. 524-525.

fragments of some others were found; these were apparently portions of a necklace. Two chisels or gouge-shaped implements, one of horn, and the other of flint, and an imperfect perforated stone implement, were also found with these remains.

On Monday, March 24, work was resumed, and a trench extending due east from the previous one was commenced, and two skeletons were uncovered. Next day, on removing the two crania, a third was found. An earthen vessel in fine preservation was found in close proximity to one of the skulls (fig. 3).

Two of these inhumations appear to have been made in a sitting or doubled-up position, and the two skulls were about a foot apart; the third skull was distant about four feet from the others, and with the exception of the right humerus, was not accompanied by other bones. A careful search failed to reveal the rest of this skeleton, and subsequent investigation has developed the fact that many skeletons are incomplete, and have been previously disturbed either by wild animals, rooting of hogs, or other causes.

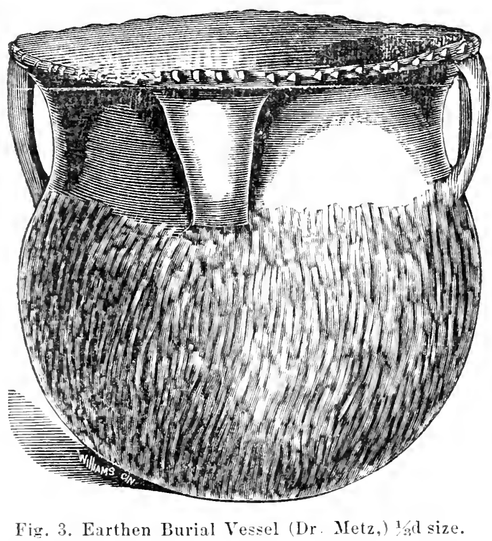

Fig. 3. Earthen Burial Vessel (Dr. Metz,) ⅓d size.

On Thursday, March 27, several members of the Madisonville Society visited the grounds and spent the day in excavating and making observations. A skeleton, in horizontal position, with head to the south, was exhumed, and near the head was found an imperfect vessel. Close to the feet of the skeleton a second was uncovered, and

later in the day a third, all nearly in a north and south line, but not all at the same depth. Near the last-named skeleton the fragments of a vessel were taken out, which has since been restored to nearly its original shape. Northeast of this skeleton, about ten feet distant, and on the north side of an oak tree, the skeleton of a small child was exhumed, and near its head was found a small two story or double vessel, which is now in Mr. W. C. Rogers' collection. This vessel was described and figured in Prof. Short's work before referred to. Near the south edge of the plateau, an excavation was made, and a skeleton in a sitting position, uncovered and removed; near this, and about twenty inches below the surface, the remains of a fire, consisting of ashes, burnt bones and limestone were found. Four feet west of the skeleton, and near the edge of a trench, opened the day before, from which two skeletons had been removed, a vessel was found by Mr. E. A. Conkling.

March 28, another skeleton, in a sitting position, was exhumed, just east of those taken out on the previous day, and with this was found a fine limestone pipe (fig. 4), now in the collection of Mr. R. O. Collis.

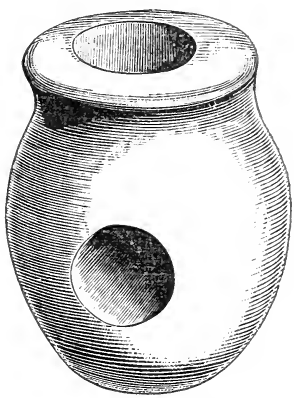

Fig. 4. Stone Pipe (R. O. Collis).

A skeleton, in horizontal position, was next exhumed, and with this two vessels were found. These remains were remarkably well preserved, and the cranium, with the vessels, is now in Dr. Metz's collection.

Monday, March 31, Dr. Metz discovered, at a depth of ten inches, a deposit of ashes about four inches thick; below this a layer of burnt limestone and boulders; below these a single round boulder, upon which was laid an elliptical flint implement, about three inches in length; the boulder rested on a layer of sand, eight inches deep, and on the clay partly covered with the sand, were two large prongs of

elkhorn. About six feet south of this spot, six skeletons were exhumed within a space of about four feet square, and in this excavation three entire and four broken vessels were found.

Tuesday, April 1st. On this date work was begun under the auspices of the Literary and Scientific Society of Madisonville. Heretofore the excavations had been made by individuals, irregularly, all over the plateau, but the importance and extent of the cemetery so evidently required co-operation and systematic exploration in order to obtain the best scientific results, that the society unanimously resolved to carry on the work, the proprietors of the ground, Messrs. A. J. and Charles K. Ferris having granted to it the exclusive privilege of making a thorough exploration of the entire tract.

In accordance with the plan adopted, Dr. Metz, who had kindly consented to superintend the work, began a trench on the south edge of the plateau running north and south; in this trench, about two feet below the surface, an inverted vessel resting on a skull was found, and upon removing this vessel another was seen immediately to the left of the cranium; these vessels were almost entire; four inches to the right of the skull, the cranium of a child was uncovered, and near it was found a broken vessel. On taking up the fragments of the vessel, a third cranium was discovered, and beneath this a fourth, both much decayed, and another vessel was found near these skulls, making, in all, four crania, four vessels, and several flint implements taken from a space not more than four and a half feet square. Next day a trench four feet wide, running east along the south edge of the plateau, was commenced and continued thirteen feet, and from it one skeleton was taken, an imperfect vessel, and a polished, ungrooved stone axe.

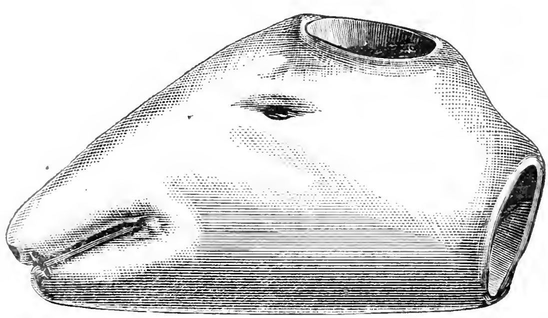

Fig. 5. Stone Pipe (Joseph Cox, Jr.)

A group of remains was here discovered, and the excavation was enlarged to about nine feet square. From this excavation, seven crania

and three broken vessels were taken ; two only of the crania were accompanied by the remainder of their skeletons.

A small vessel, capacity about one pint, rested on one of the skulls, and a second vessel was found a few inches from it; two rough stone axes, or fleshers, and a stone pipe (fig. 5), were also taken from this excavation.

Work was resumed on the north and south trench, and continued during the following week. Seven skeletons were exhumed, of which six were adults, in sitting or doubled-up positions, and the other a child, horizontally interred. One vessel, in fair preservation, another in fragments, and some flint and stone implements were also found.

On Friday, April 11, seven skeletons were uncovered, all in a horizontal position, but irregularly disposed, and having the bones mingled together. Some of the bones were remarkable for their stout build and extraordinary development of the ridges and points of muscular attachment. Three vessels, and half of another, together with an ornamented limestone pipe (fig. 6), were found with these remains.

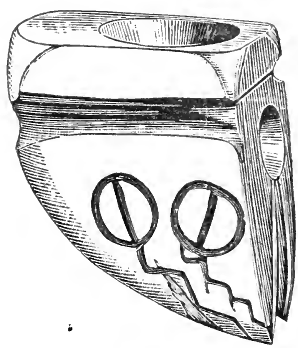

Fig. 6. Stone Pipe (C. F. Low).

During the excavation on April 12th, near the south edge of the plateau, a single detached cranium was uncovered. In searching for the bones belonging to this skull, a circular pit was made, about $3\frac{1}{2}$ feet in diameter, and $4\frac{1}{2}$ feet deep, from which sufficient crania and bones were taken to identify twenty-two skeletons. In addition to the description of this remarkable deposit, published in Prof. Short's work before referred to, it is, perhaps, worthy of note, that many of the crania taken from this pit were compactly filled with snail shells, of which *Helix alternata*, *H. solitaria* and *H. fallax* have been identified. These crania had, perhaps, been utilized by some rodent as store houses for its winter supplies, or else were occupied as winter quar-

pied as winter quarters by the snails, some dying, and thus accumulating from year to year.

On Monday, April 14, work was resumed, two men being employed in excavating. Five skeletons were exhumed, all in a horizontal position. A finely finished pipe, of curious form, and made of dark red catlinite, was found (fig. 7).

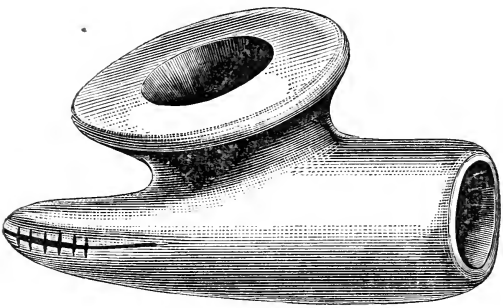

Fig. 7. Catlinite Pipe (E. A. Conkling).

The following day, five skeletons in one group, all in sitting positions, and a small thin piece of copper, about one inch square, were found.

Wednesday, April 16, three skeletons, five vessels, and a number of flint implements were exhumed. Two of these crania have been presented to the Smithsonian Institution, and Dr. Emil Bessels, anthropologist to the Institution, has reported on them as follows:

"Skull marked No. 1, is evidently that of a male. It is very large, with strong, muscular insertions, especially in the parietal and occipital regions. The osseous tissue is rather incompact, and in consequence the skull itself is rather light, like the bones of those savage tribes living mainly on vegetable food. The two teeth that are left in the upper jaw show strong marks of caries, something not often met with among North American Indians. The frontal bone shows a number of osteophytic formations. Age between 40 and 45 years.

"Skull marked No. 2 is that of a female, and exhibits a number of characters common amongst low races. It is highly prognathous; its cheek bones are high; it has a broad, nasal bridge, and a large, nasal meatus; the frontal region is narrow; the parietal tubers are strongly marked. Between the linea suprema, and the linea inferior, of the occipital, that characteristic formation is found to which Ecker has lately drawn attention, and which he calls the sorus occipitalis.

This skull is even lighter in proportion than No. 1. Age between 28 and 33 years."

On Thursday, April 17, two more skeletons, in horizontal positions, were found, the crania of which were preserved in fair condition. A circular excavation, about three feet in diameter, was made to-day, and a quantity of *unio* shells, ashes, animal remains, sherds of pottery, and one bone awl were taken out.

An earthen vessel, unaccompanied by any human remains, was dis-

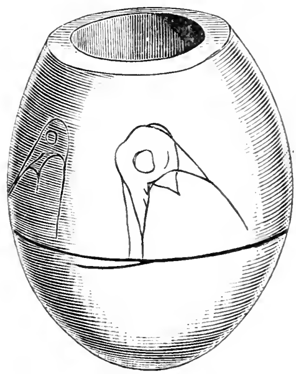

Fig. 8. Stone Pipe (G. W. Lasher).

covered on Saturday, and an ornamented stone pipe (fig. 8) was found in the same excavation, but about ten feet distant from the vessel.

On the 21st, a portion of a skeleton, without the cranium, was found a few inches below the surface. During the past five days, a strip, sixty feet long, and about forty feet wide, had been dug, and but three skeletons had been found, in remarkable contrast with the results of the previous week, when thirty-five skeletons, within a space not more than fifteen feet square, were removed.

On Tuesday, 22d, a pit was opened, similar to that found on Thursday, and under the direction of Dr. H. H. Hill, who was on the ground that day, a more careful examination was made of these curious excavations, which have since been called " ash pits," from the fact that they all contain one or more layers of ashes, varying in thickness from a few inches to two or three feet in different pits. This pit was about three feet in diameter, and four and one half feet deep; neither the sides nor bottom show any traces of the action of fire, and it is apparent that the excavation was first made, and the ashes deposited, *as ashes*, in layers from 6 to 12 inches in depth, aggregating some two or two and a half feet. In this ashes, which doubtless contributed largely

to their preservation, are found numerous animal bones, *unio* shells, and fine bone implements, which retain, in a remarkable degree, their polish, notwithstanding their long burial in these deposits.

From one of the pits opened this day was taken the first of the curious grooved bone implements which have excited so much interest and speculation as to their probable use, and are pronounced by our most experienced collectors to be unique.

They are usually made from the leg bones of the deer or elk, grooved in a peculiar manner, and beveled on the inner surface of the walls of the bone; the outer edges are quite smooth and polished from use, while the marks and scratches of the tool employed in their manufacture, or perhaps in the use of the implement, run the whole length of the groove, but contract to a curved point at each extremity.

The implement was probably in use until the walls of the bone had been worn down on each side, which so weakened the implement that they were broken and thrown aside. Fragments of these implements are the most common of the numerous bone relics found in these ash pits, but whole or unbroken ones are quite rare, only three or four having been found. Illustrations are given of the largest and best preserved one yet found. See Plate I.

This implement is made from the right femur of an elk, and is figured in two positions, two-thirds natural size. Fig. 1, a front view, shows the peculiar bevel; fig. 2, the irregular curve in the implement, the probable result of use; fig. 3 represents a smaller and more common implement, made from the third metacarpal bone of a deer; and figs. 1 and 2 of Plate II. show fragments of these implements.

On Wednesday, April 23, a second ash pit was explored, but only a few fragments of pottery were found. Close by this pit, a large skeleton, 6 feet 2 inches in length was uncovered. These remains were in a horizontal position, and badly decayed, but a portion of the cranium was preserved as an interesting pathological specimen. In the right parietal was a perforation, the effect of a blow which had crushed the skull, and which had been repaired and almost obliterated by an internal deposit of new bone.

Another ash pit was opened on the following day, and several bone implements, together with animal remains and sherds of pottery were found. One skeleton, in a sitting position, and two in horizontal, with heads toward the south, were also removed. With these two latter skeletons were found small vessels, one at the head of each,—one of which is here represented (fig. 9). Fragments of two other vessels were found in the same excavation.

Friday, April 25. numerous fine bone imp'ements, and several made of deer horn, were taken from the ash pits opened to-day. Several members of the Society were on the ground, and during the day seven skeletons were exhumed. Two were in sitting positions, three horizontal, with heads to the south, and two others in the same position with heads directed east. A nearly perfect vessel, and fragments of another

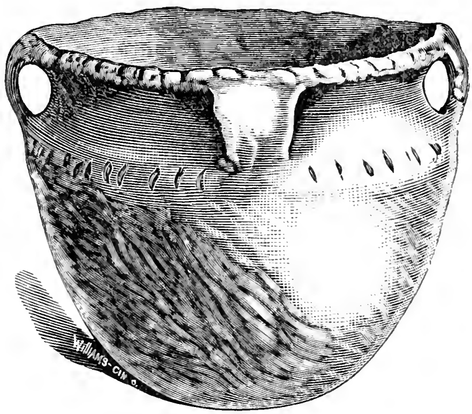

Fig. 9. Small Vessel (C. F. Low). ½ size.

were taken from near the crania of those lying north and south. A polished stone implement (chisel shaped), was found lying by the side; and among the bones of the right hand, a medium-sized jasper spear-head was discovered. The third horizontal skeleton was of small size, and the skull rested upon the pelvic bones of the second skeleton.

Saturday, April 26, two skeletons, with heads southeast, lying in horizontal position, were uncovered. Each was accompanied by a vessel, one of which was nearly perfect.

Monday, April 28, two ash pits explored, one 5 feet 7 inches, and the other 4 feet 8 inches in depth. Numerous fine relics and implements were taken out of these pits. Among other things, a large fragment of a molar tooth of *Mastodon americanus*. During this week, fourteen ash pits were opened, and five skeletons exhumed. The notable relics found were a sandstone pipe, a perforated stone disk, numerous fine bone awls, bone beads, and implements of bone and flint; one large vessel, of about three quarts capacity, and another quite small, not larger than an ordinary teacup—the latter was found with a child's skeleton.

Wednesday, May 7th. Ten feet east of station 1,* which is located

* These "stations" are stakes driven so as to divide the ground for platting; the skeletons are located by means of these stakes, on a chart of the cemetery now in course of preparation.

on the extreme western edge of the plateau, a skeleton six feet in length was found buried about eighteen inches below the surface. It was lying in a horizontal position, head east, and face upward. Near the head was a finely shaped ornamented vessel, and in lieu of the usual handles were two perforations on each side, and two small projections on each quarter; a finely polished catlinite pipe was found near the head of this skeleton; these relics are shown in figs. 10 and 11.

Fig. 10. Ornamented Vessel (G. W. Lasher). ⅓ size.

A second skeleton, lying at right angles, with the head directed north, was discovered immediately at the feet of the preceding skeleton, but with these remains no relics were found.

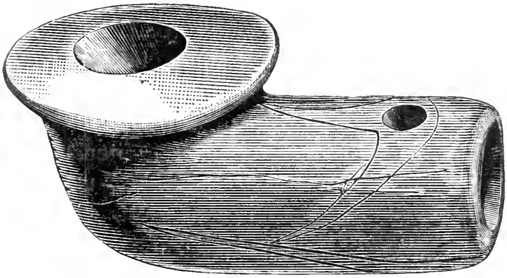

Fig. 11. Catlinite Pipe (R. O. Collis).

Thursday, May 8th. The ground was visited by Dr. H. H. Hill and R. B. Moore, Esq., of Cincinnati, in company with several mem-

bers of the Madisonville Society. A skeleton about six feet in length, and finely developed in all respects, was found lying in a horizontal position, with head to south and face upward. The cranium of this skeleton, which is numbered 4 on a table of cranial measurements, now in course of preparation, is in a remarkably good state of preservation, a circumstance which is accounted for, in part at least, by the perfect development and compact texture of the osseous tissue, being in these respects in marked contrast with those referred to by Dr. Bessels in his letter before cited. It is the cranium of a male, apparently in the prime of life, the teeth being all present and perfect, with the exception of a decided flattening of their crowns from use; an estimate of its age would probably place it somewhere between 40 and 45 years.

It is especially noticeable for its large size, having an internal capacity of 1,660 cubic centimeters; thus exceeding by 150 c. c. the average of European skulls, according to Barnard Davis,* and ranking among the largest aboriginal crania on record.†

It exceeds the average of 14 other male crania from this cemetery by 266 c. c.; that of 39 crania from mounds in the United States‡ by 286 c. c.

In shape it is symmetrical to the eye in all aspects, and would be classed among the Brachycephali, in common with the large majority of its fellows, having an index of breadth of ·840. The anterior cerebral development is not in proportion to its total capacity, the forehead being low, narrow and somewhat retreating, rather more so in fact than the general average of crania from this cemetery, some of which approach the classical in profile; its deficiencies in these respects are amply compensated for, however, by its great width in the bi-parietal region, and at the base. There are no traces of the occipital flattening, so common among aboriginal skulls, but in this respect, as in others, it is an exception. The right occipito-mastoid suture contains a Wormian bone, about one inch in length, and half an inch in width, and there are traces of a similar one on the opposite side. The lambdoidal suture is obliterated at some points, but the

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* *Vide* Thesaurus Craniorum, p. 360.

† Four of the largest known American Crania are mentioned by Carr, in the 11th An. Rep. Peabody Museum, 1878, p. 383, viz: 1,825 c. c. from Tennessee, Stone Grave Mounds, No. 12,797 Peabody Museum; 1,785 c. c. from an Illinois Mound, Army Med. Mus.; 1,704 c. c., Shawnee Indian, Schoolcraft on "Indian Tribes of the United States," vol. ii , p. 330; 1,688 c. c., Tennessee Stone Grave Mounds, Smithsonian Collection of Dr. Jones. In addition to these, there is one in the Peabody Mus. (No. 13,250), from the Santa Barbara Islands, California, with a capacity of 1,680 c. c.

‡ *Vide* Check List Army Med. Mus., cited by Carr, 11th An. Rep. Peabody Museum.

other cranial sutures are persistent throughout. The squamo-parietal suture presents, on both sides, a sharply cut furrow, about one inch in length, extending upward and backward from its middle third. The anterior inferior angle of the right parietal is chiefly formed by a small Wormian bone.

The face does not show the slightest tendency to prognathism, being here an exception to the prevailing form from this locality; the orbital and nasal cavities do not exceed the average in size; and the nasal septum is deflected toward the left. The superciliary ridges are more than usually prominent, but the temporal ridge seems rather deficient than otherwise, contrary to what might be expected in case of extreme general muscular development.

A noteworthy anatomical feature is the development of a well-marked process, which projects from the posterior border of the malar bone, and partially covers in the temporal fossa. This process, which might with propriety be termed the temporal process of the malar, is present to a greater or less extent in a large proportion of the crania from this locality, being in some extreme cases developed upward and backward into a decided hook. It is also occasionally observed in the skulls of negroes, although it has not yet been described by anatomists, so far as the writer has been able to ascertain. The incisive suture is not persistent in this cranium, although it is more or less visible in several of the others.

The teeth, as before mentioned, are perfect, and all present, with one addition to the normal number; the supernumerary tooth is situated internal to and between the two pre-molars on the right side. It has a single cusp, which tapers to a point, and terminates on a plane corresponding to that of the adjacent teeth, which are of normal size and development. This cranium, with others from the same locality, has been donated to the museum of the Cincinnati Society of Natural History. Front, lateral and vertical views are represented on Plates II. and III.

A second skeleton was uncovered a short distance north, with head directed northeast, and close by were found the remains of four others, in sitting positions, and very close together. On removing these four crania, five inferior maxillæ were found. Immediately beneath this group of skeletons was an ash pit, measuring four and a half feet in depth, and three feet in diameter, from which an unusual quantity of animal remains and *unio* shells were taken. In another ash pit explored this day, was found a human vertebra (from the dorsal region); as this is the only human remains found in any of these pits to this date, it is

quite likely that this fragment may have fallen unnoticed from the surface during the excavation. Some fragments and handles of an unusually large vessel were taken from this pit, and the bottom was found to be covered with nearly half a bushel of *unio* shells.

A summary for the week ending May 10, shows fifteen ash pits explored, eleven skeletons exhumed, two vessels, and many bone, flint and stone implements found.

Tuesday, May 13, an ash pit was opened, from which was taken a harpoon or fish spear, made of elk horn, and several fine bone relics; four skeletons very much decayed were also found, and two rolls of sheet copper about $1\frac{1}{2}$ to 2 inches in length, and $\frac{1}{4}$ inch in diameter. During this week were exhumed six skeletons, and six ash pits opened. On Saturday a cross section was made of one of these pits, by excavating from the outside, and the following diagram (fig. 12) illustrates the usual arrangement of these pits.

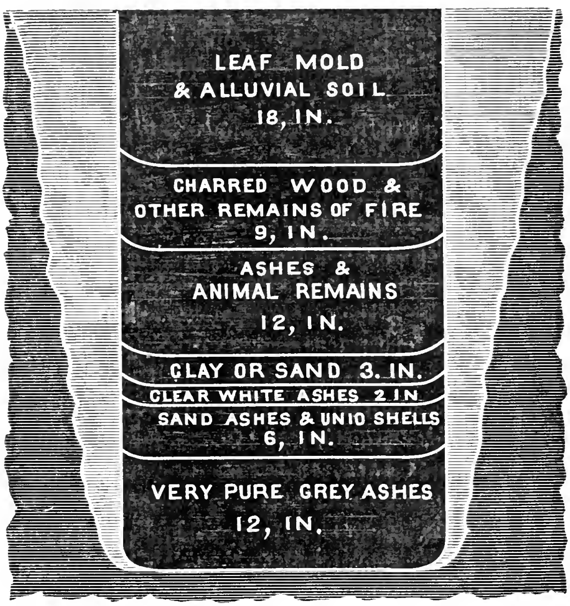


Fig. 12. Diagram of Ash Pit, No. 53.

In opening these pits, many of the layers are intermixed with each other, but as a rule the layers are distinct, and can be readily determined on the sides of the excavation. Below the second layer, the contents are not charred; in some pits the ashes will measure $2\frac{1}{2}$ feet without any noticeable partings. A record is kept of

every pit explored, and the diameter and depth of the layers, as nearly as practicable. Any variation from the usual condition is noted, but in this paper it is not necessary to enter into the details of each pit, and mention will only be made of those which show some marked variation, or from which fine relics have been taken. In exploring these pits, the earth and ashes excavated are thrown on to a coarse wire screen, and fragments, of every description, are carefully gathered up and laid aside for further examination. Among the animal bones taken from the ash pits are many specimens of special interest zoologically, as representing species now extinct in this region; a list of these is reserved for another occasion, as some specimens yet require identification.

Many of the vessels found with skeletons exhumed, contain a shell which in every instance has been identified as *Unio alatus.* There are also numerous perforated implements found in the ash pits, made from the shell of *U. plicatus*, of which the following (fig 13) is an illustration of the largest yet found.

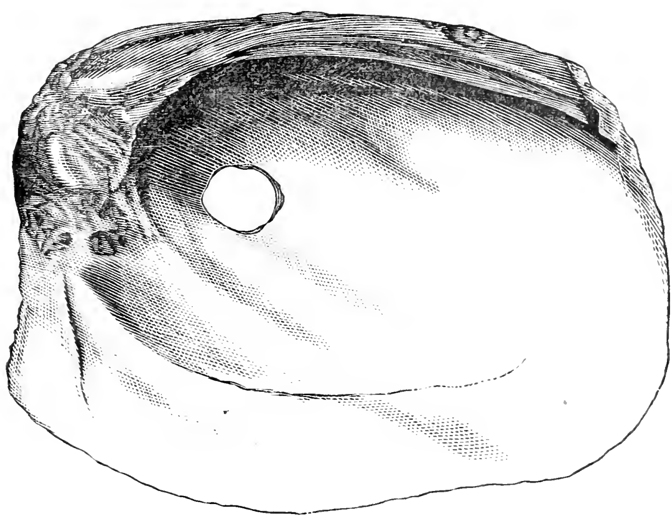


Fig. 13. Perforated Unio Valve. One third size.

From May 19th to 24th, five ash pits were opened, and four skeletons exhumed. An adult skeleton found on Saturday, was buried in an extended position, head to the south, face upward. On the right of the cranium a limestone pipe (fig. 14) was found, and on the left side two

large fossil bivalves, *Orthis lynx* and *O. occidentalis.* Eight small tips of deer horn were found in proximity to the neck, together with a polished bone cylinder two inches in length, several arrow points, and some flint chippings.

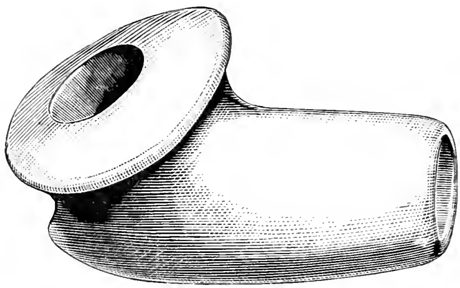


Fig. 14. Stone Pipe (A. A. Hawes).

During the next two weeks the work of excavating was very much interrupted by severe rain storms, and although considerable ground was explored, the results were quite meagre, only eight ash pits and but four skeletons were found.

On Friday, June 13th, an excavation was begun on the southeast section, near the edge of the plat. Here a group of three skeletons was discovered, one adult male, an adult female, and a child of about 8 or 9 years of age; these skeletons were placed horizontally, heads southeast; with each was a vessel, and with the child, in addition to the vessel; two bone beads and a set of shell ornaments (3 pieces), were found on its neck and chest. Of the crania only one, that of the female, could be saved. Two imperfect stone pipes were found within two feet of the female, and to the right of this skeleton, 10 inches below the surface, a bed of ashes about four feet square and five inches thick was discovered.

On Saturday, 14th, another group of three was found, two adult and one child about 14 years of age, one adult skeleton and the child lay in horizontal, the other in sitting position, heads directed southeast ; two fine elk-horn implements were found with the child.

On Monday, June 16th, the skeleton of a very old person was uncovered ; its position was partly extended, lying on its side, face east, with hands raised and knees projected, as illustrated in the following cut (fig. 15.) This cranium was preserved in fair condition.

On Tuesday, June 17th, two skeletons were found, immediately over an ash pit; they were in semi-extended positions, heads directed east,

and lower limbs crossed, as per illustration (fig. 16). The ashpit was 5 feet deep and 4 feet in diameter, and contained ashes and sand, a

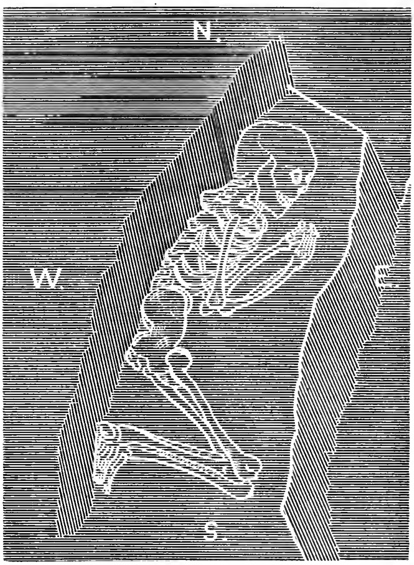


Fig. 15. Skeleton of Old Person.

few fragments of burnt bone, and on the bottom about 6 inches of calcined *unio* shells.

On Friday, June 20th, an adult skeleton was discovered, at a depth of 2½ feet, over which was a layer of thin limestone, of small size, that had evidently been brought from the neighboring ravine. An earthen vessel was found near the right hip, the head was toward the north, and directly over the face, but 12 inches above it was found another small vessel. This is the only skeleton yet discovered that was covered with stone. An adult skeleton, with head southeast, was found on Saturday, the 21st. Near its extremities was the skeleton of a small child, about 3 years of age, lying parallel with it. During the week three skeletons were exhumed and two ash pits explored, in addition to those mentioned.

Monday, June 23d, excavations were begun in the adjoining tract of woods near the Spice Bush Mound, by permission of the owner, Mr. C. F. Stites, with a view of ascertaining the extent and boundaries of the cemetery. In the immediate vicinity of the mound referred to were several slight elevations, with circular depressions in the center,

18 inches to two feet in depth. Four of them were opened, by digging a trench 3 feet wide and about 20 inches deep through the center of each. In one a bed of ashes was found 20 inches below the surface,

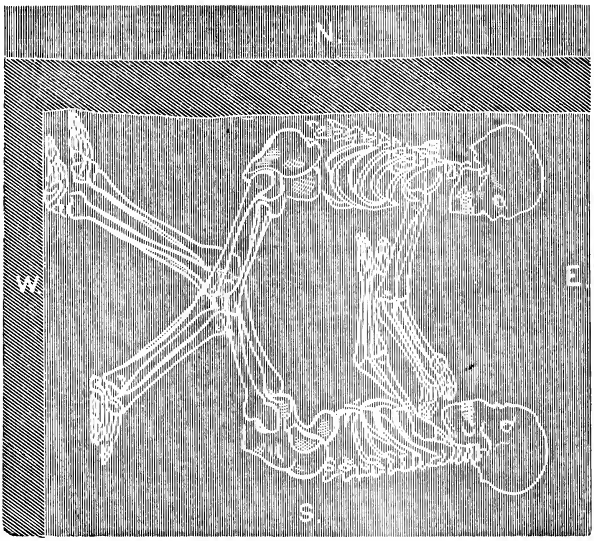


Fig. 16. Two Skeletons.

containing sherds, animal remains and charcoal. Near the edges of these depressions an occasional arrow point or stone implement was found.

On the 28th, a skeleton, accompanied by a vessel, was exhumed near the edge of the bluff. This was an adult skeleton, in horizontal position, head to the south, but was badly decayed, and could not be preserved. During the following week several others were exhumed in different localities, proving, conclusively, that the whole plateau was one vast burial ground, although in this portion of the cemetery the skeletons were more scattered and not so well preserved.

The fact having been fully demonstrated that the whole tract was of this character, on Monday, July 7th, the work of systematic excavation was resumed in the Ferris Woods, and four skeletons, in horizontal positions, irregularly disposed, were exhumed.

On the 9th, another skeleton, in same position, was discovered; with this a curious, gourd-shaped earthen vessel was found (fig. 17).

Thursday, July 10th, five skeletons were uncovered, of which two were children 8 to 10 years of age. The fourth skeleton, which was

an adult, had imbedded in one of the lower dorsal vertebræ, one of the small, triangular flints, termed "war arrow points;" several flint arrow

Fig. 17. Earthen Vessel (Joseph Cox, Jr.) Half size.

heads, and a thin piece of copper, about $1\frac{1}{2}$ inches square, were also found with these remains.

Monday, July 14, three skeletons were exhumed, lying in a horizontal

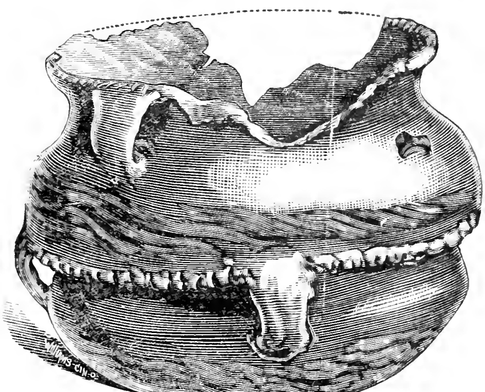


Fig. 18. Small Double Vessel (G. W. Lasher). Half-size.

position, close together and parallel; the head of one was directed north, and face upward; the other two with heads toward the south;

one of them lay on its side, facing west; the inferior maxillæ of these latter crania were both missing, but were afterwards found together some two feet distant. About three feet east of this group the skeleton of an infant, buried about eighteen inches deep, was found, and with it a small vessel, inside of which was a still smaller one.

Next day seven skeletons were found, of which two were children, and with one of these a small, two-story vessel (fig. 18).

The inferior maxillæ of two of these skeletons were also missing, and could not be found.

During the remainder of the week, twenty skeletons were exhumed, disposed in groups of from three to seven. On Saturday, at the feet of one of the skeletons, was found a fine, perfect vessel, capacity about one gallon (fig 19).

Fig. 19. Large Vessel (C. F. Low). One third size.

The lower extremities of one of the skeletons exhumed this day, extended under the stump of a walnut tree about three feet in diameter; another was found lying on its side, head south, with lower extremities extended west at right angles to the rest of the body.

Monday, July 21, at a depth of twenty-three inches, two skeletons were found, lying horizontally; heads southeast and face upward. One of these skeletons was incomplete, the cranium and lower extremities missing. Two feet east of them, another skeleton, in sitting position, was discovered, and, from near the head, a tall, egg-shaped vessel was taken. Next were two children, at a depth of twenty inches, lying

horizontally; heads southeast; a medium-sized vessel was found near them; immediately beneath the skeletons of the children was an ash pit, five feet five inches deep, and two feet ten inches in diameter, containing about four feet of ashes; several large fragments of pottery were taken from this pit, forming about one half of a vessel of several gallons capacity, and in the middle of the pit nearly a bushel of *unio* shells were found.

Tuesday, July 22d, an adult male skeleton, in sitting position, was found at a depth of twenty-two inches, another adult male in horizontal position, head southeast, was found about one foot northeast of the above. At the right side of the cranium was a medium-sized ves-

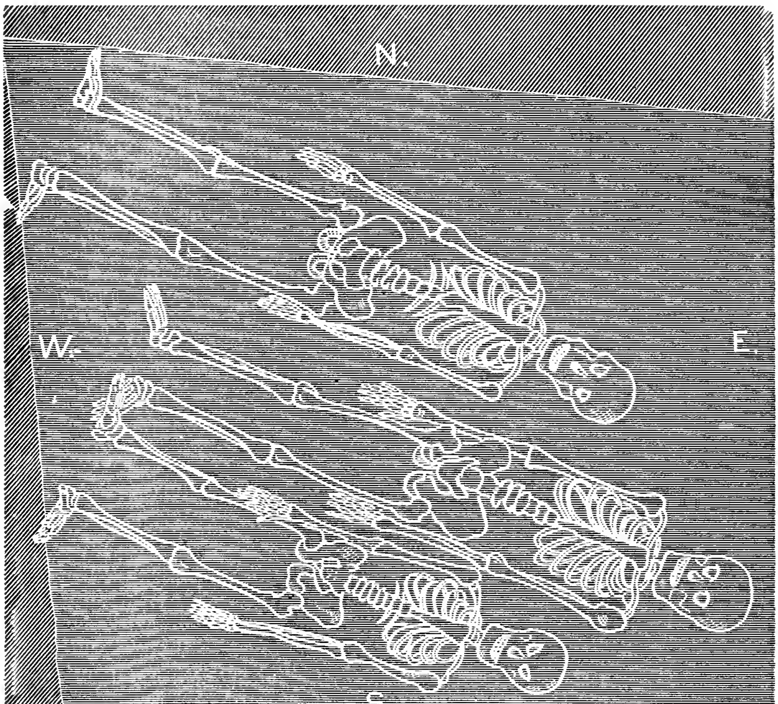


Fig. 20. Group of Three Skeletons.

sel, nearly perfect; an implement of elk horn with two perforations, a stone disk, some bone beads, and a piece of cannel coal were found with these remains. On the following day, a few feet northeast of the preceding skeleton, a child's skeleton in horizontal position, with head

southeast was exhumed; with this was found a broken vessel, a grooved stone hammer with a + on each end, and one triangular arrowhead.

Another skeleton, an adult, in horizontal position, head southeast, was found directly northeast of the above; the broken vessel accompanying this skeleton was placed at the top of the head; an ash pit four feet nine inches in depth, and four feet in diameter, was also explored to-day, and a fine gouge or chisel made of elkhorn, some bone awls, and several fine flint implements were taken out.

On Thursday, July 24, an adult female skeleton, in sitting position, facing north, was found about two feet northwest of the above ash pit; at the right side of this skeleton lay the skeleton of an infant, in horizontal position, and about one foot west on the left lay another child's skeleton, also in horizontal position.

On Friday, another ash pit was found, four feet deep and three feet three inches in diameter. Over this ash pit lay a skull without the inferior maxillæ, and in the ash pit the bones of a single arm were found,

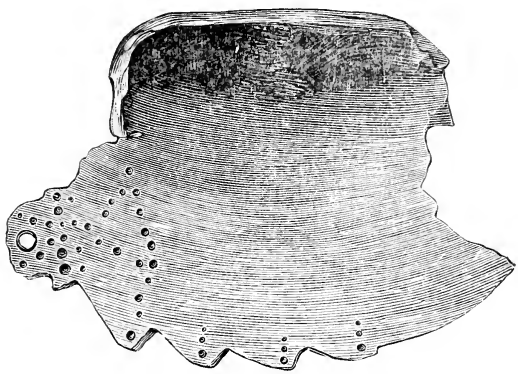


Fig. 21 Shell Ornament (D. S. Hosbrook).

at a depth of two feet. The next skeleton was situated about one foot northwest of the ash pit. It was an adult, lying horizontally, head west, and at the top of the head an oblong vessel, with four handles placed differently from those of any other yet found—two at each end, instead of being equidistant. Directly west of this last skeleton the remains of a child, in horizontal position, with head southeast, were exhumed. A second ash pit was explored, and four other skeletons were taken out during the day.

From July 28th to 31st five ash pits and six skeletons were discovered. Of these, three found on the 31st were buried in a peculiar

group, as shown in the following sketch (fig. 20.) On the following day six skeletons of children and one adult were found. With the latter a vessel was discovered, which contained a shell ornament (fig. 21.)

From August 4 to August 19, six ash pits and fourteen skeletons, disposed in groups, were found, and with each group one or more children.

On August 20, another singular group (fig. 22) of skeletons was ex-

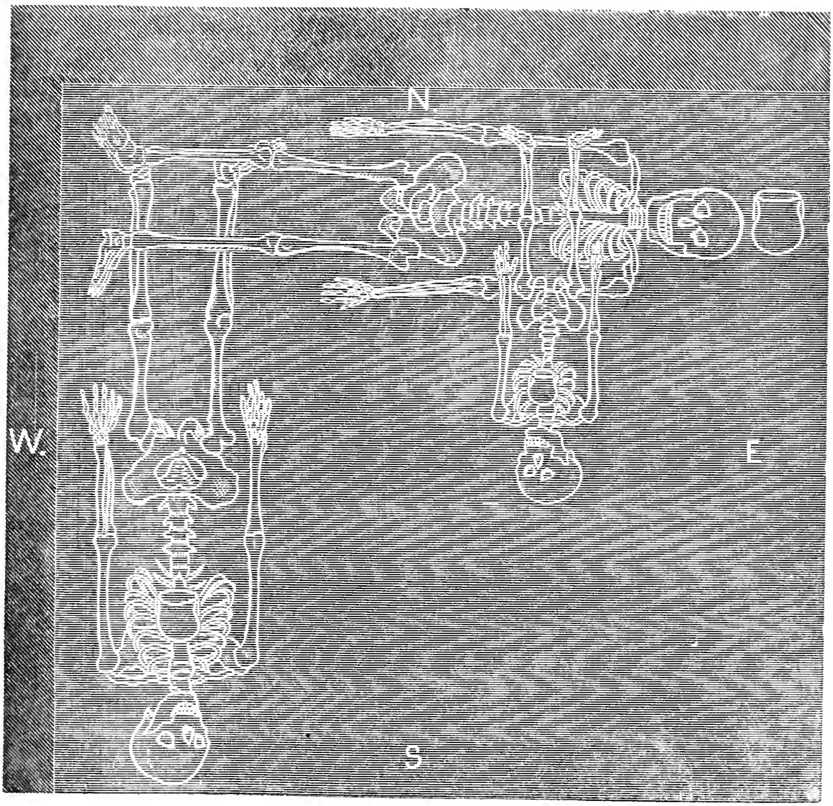


Fig. 22. Group of Skeletons.

humed, at a depth of three feet. One adult lay with head south, and the lower extremities were overlaid by the extremities of another adult, who lay with head east. The third skeleton was a child, with its head south, its lower extremities extending over the chest of the second skeleton. On the chest of the first skeleton a vessel was found, and another on the chest of the child, while with the second skeleton the

vessel had been placed at the top of the head. A finely-polished stone implement was also found with the group. Three feet east of the second skeleton in the above group, at a depth of twenty-one inches, the skeleton of a very large adult, evidently female, measuring six feet in length, was found. The head was directed south, and a large vessel was deposited at the feet.

On Thursday and Friday, a group of six skeletons was found. Five were adults, and one a child about six years of age. All of these skeletons were in horizontal positions, heads directed east and with each

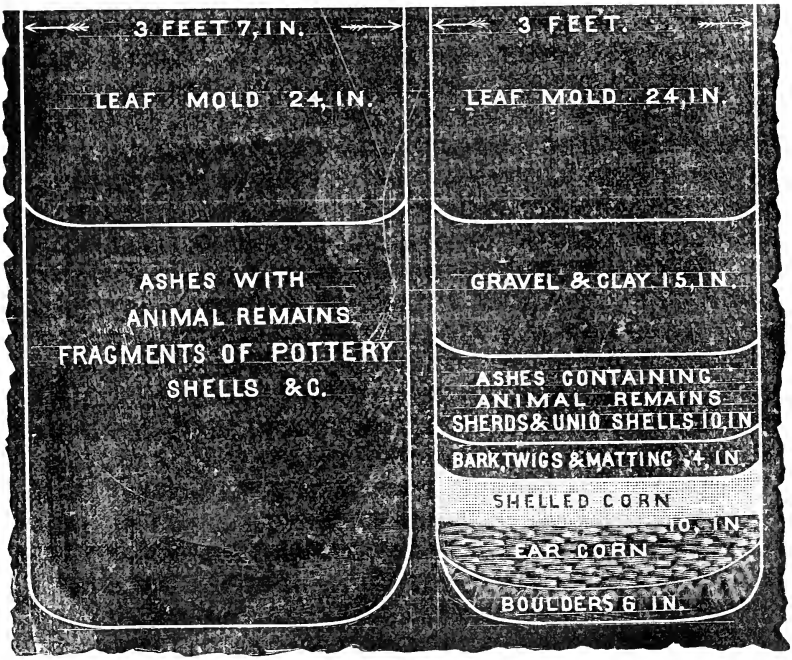


Fig. 23. Diagram of Double Corn Pit.

was a vessel placed at the left of the cranium. Beneath the head of the last one was found a polished flint celt and a stone implement.

On Tuesday, August 26th, one of the most interesting discoveries in this cemetery was made. In excavating an ash pit, a large deposit of several bushels of carbonized maize was found. Newspaper accounts of this remarkable discovery were published at the time, which were more or less erroneous. A correct diagram of the pit is here given, with a brief description of its contents.

Layer No. 1 consists of about two feet of rich black earth and leaf

mold. No. 2 is fifteen inches of gravelly clay, in which was found numerous animal remains, several implements of flint, stone and bone, an unfinished pipe, and some charred animal bones.

Next came layer No. 3, about ten inches of ashes, intermingled with bones of a great number of animals, of which the following were identified: Deer, elk, raccoon, opossum, mink, woodchuck, beaver and turkey, together with *unio* shells of various species. Immediately below this was a layer (No. 4), about four inches thick, of coarse matting and twigs, corn stalks and bark, completely carbonized. No. 5 was a layer of shelled corn, probably three or four bushels, and below this was a quantity of ear corn, all of which was completely carbonized. On the bottom of the pit was a layer of fire-cracked boulders, with some ashes and a few animal bones. The adjoining pit was separated from the corn pit at the bottom by about six inches of clay, and did not differ from the usual pits, except that no implements were found in it.

August 29th and 30th, two ash pits were explored, from which the usual implements were taken, and an unfinished pipe representing a bear on its haunches. An adult skeleton was also exhumed, lying horizontally, head south and face upwards; a vessel was found at its feet. Immediately under this skeleton was an ash pit three feet in diameter, and four feet ten inches deep.

This paper brings the details of the work of exploration in this cemetery up to August 31, 1879.

It is not intended, at this time, to make a summary, or to present any theoretical conclusions, although it is proper in this connection to state that among all the numerous relics found in exhuming four hundred skeletons, and exploring over two hundred ash pits, nothing has yet been discovered *in situ*, which shows any evidence of association with European races; and while many of the implements are similar in form and material to those of the so-called "mound builders," and the pieces of copper and marine shells indicate commercial intercourse with distant nations or tribes, neither ornament nor artistic design can be traced to any European source. This fact, in addition to the age of the forest trees, beneath which several of the skeletons have been found, places the age of these remains at a date prior to the earliest French or Spanish explorers of America; how much older than this is purely a matter of conjecture. The preservation and description of these implements, ornaments and utensils of a pre-historic people, and the ethnological facts developed in connection with them, will add another chapter to the record from which, at some future time, their history will probably be written.

We have here all the materials necessary to determine their daily domestic pursuits. Implements and tools of stone, flint and bone, pipes ornamented and carved to represent animals, ornaments of shell and copper, and even musical instruments are not wanting. Their pottery is a study in itself; the designs of the ornamentation on some, and representations of animals and the human face on others, show a good degree of artistic taste. And another thing is very noticeable, viz: the scarcity of warlike implements or weapons, which, with other evidences, goes far to show that they were a peaceable, industrious race, cultivating, to some extent, the earth, but mainly dependent upon the products of the forest and the adjacent rivers for their subsistence.

The favorable weather during the fall and winter has permitted the work to go on without interruption and many new and interesting discoveries have since been made, an account of which will form the subject of a future paper.

ANNUAL REPORT OF THE TREASURER OF THE CINCINNATI SOCIETY OF NATURAL HISTORY, FOR THE YEAR ENDING APRIL 1, 1880.

RECEIPTS.

There has been received into the Treasury, from all sources, during the year ending April 1, 1880, $9,050 52.

The items are as follows.

Dues of the past year	$318 00	
Dues of preceding years	265 00	
Initiation fees	35 00	
		$618 00
Life membership, one		50 00
Interest on investments, as follows:		
On U. S. Bonds, part 6 per cent. and part 4 per cent.	$74 50	
On Little Miami R.R. Stock, $1,000 at 8 per cent.	80 00	
On Cincinnati Southern Railway Bonds, $2,000 at 7.30	73 00	
On mortgage loans	4,683 97	
		4,911 47
Sales and subscriptions to JOURNAL		15 00
Investments collected in, as follows:		
U. S. 6 per cent. Bonds, "called"	$1,250 00	
Mather loan, part collected	2,109 90	
Sollenberger note, balance paid in full	96 15	
		3,456 05
Total amount received as above stated		$9,050 52

PAYMENTS.

There has been paid as follows:

On account of the Museum (most of this is on appropriations made the year preceding: Elephant, $100; and Crinoids, $150)	$291 75	
For printing, engraving and lithographing, 3 Nos. of JOURNAL	783 25	
Bookbinding	14 25	
Printing draft of new constitution and by-laws	10 00	
Salary of Janitor	300 00	
Repairs of building	37 05	
Fuel, gas and water	71 94	
Secretary's expenses (printing, postage and stationery)	52 24	
Treasurer's expenses, percentage to collector, 2 years, amount collected, $520 at 8 per cent.	41 60	
Attorney's fees in the Mather case, $5,600 collected by suit	200 00	
Incidental expenses connected with the case	1 90	
Paid out on re-investments, viz.:		
U. S. 4 per cents. bought, $1,250; prem., $32 50	1,282 50	
Cincinnati Southern Railway bonds, $2,000 7.30s, and prem.	2,290 00	
Various petty expenses, including postage, expressage, lectures, and expenses of curators and janitor, in all	21 03	
		5,397 51
Balance of receipts over expenditures during the year		$3,653 01
To which is to be added the balance on hand last April		146 48
Cash on hand April 1, 1880		$3,799 49

The following separate statements are submitted herewith:

Detailed list of dues and initiation fees collected during the year	$618 00
Detailed statement of interest collected during the year	4,911 47
List of investments collected in, during the year	3,456 00
List of new investments made during the year	3,572 55
List of investments as they stand at this time	40,232 10
List of paid-up members	67, less 5 resigned
List of members *not* paid up	49, amount due, $322 50

PERMANENT IRREDUCIBLE FUNDS.

The Society has several distinct funds which are required to be kept separate on the books, and can not be reduced in amount.

1. The *Subscription Building Fund* was created some years ago by certain members who agreed to make annual payments for five years. The whole amount paid in was $705, which has accumulated by constantly adding the interest, until it is now nearly $1,000. This fund is under the control, for building purposes, of those members of the Society who contributed to it.

2. There is a small *Endowment Fund*, consisting of $351.45, received from the old Western Academy of Sciences, and a donation of $200 received from Mrs. Warren: In all, $551.45. This has to be kept invested, and the interest is applicable to the general purposes of the Society.

3. The *Life Membership Fund.*—This fund is yet small. Since Life Memberships were fixed at $50, two members have availed themselves of this method of providing permanently for their dues. Fifty dollars invested by a member in this fund, pays him ten per cent. interest. Members who have come into the Society *to stay*, would do well to remember this.

4. The *Bodman Fund.* This munificent gift of the late Charles Bodman, of $50,000, subject to no conditions whatever, was received in full by the trustees, in July, 1877. The Society set apart $12,000 of this to be applied to securing a piece of property for our sole use and control, and as a permanent home for the time being. Under this provision the building we are now in was bought. Its purchase and improvements to adapt it to the use of the Society, have cost within $688 of the amount set apart for the purpose.

The remainder of the Bodman gift, $38,000, the Society directed to be invested by the trustees, and kept at interest until otherwise ordered. This was carried into effect, and we are now in the regular receipt of the proceeds. The amount of the Bodman fund actually invested is about as much over the $38,000, as the cost of our real estate falls short of the $12,000.

The payment of the interest regularly on one of our loans, was, as many of our members know, suspended during the year 1878; but during the past year all arrearages were made good, by suit, and a part of the principal of that loan was collected and invested in securities of a different character; while the original mortgage security is still held for the balance of the loan.

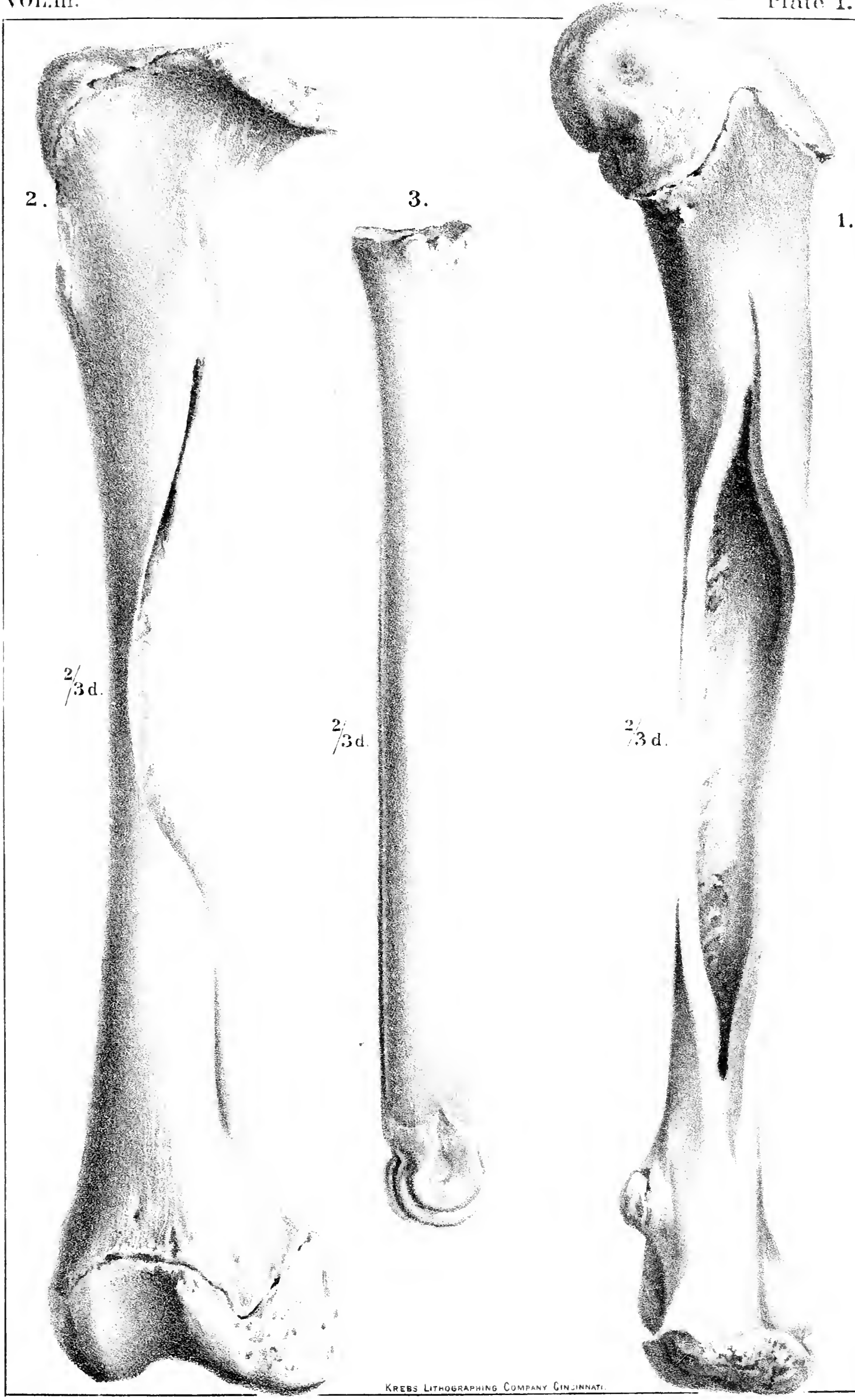
The average annual income of the Society is about $3,500; and we have now on hand such a surplus of our general funds as might justify the Society in directing a temporary investment of ten or fifteen hundred dollars.

During the past year dues and initation fees have been paid by one hundred members.

The number of members who have paid up their dues to the end of the year just closed, is 67; and 5 of these have resigned with their last payment; having 62 paid-up members (exclusive of life-members from the former Academy of Sciences). 49 members owe, up to date, for one or more years; 4 of these have removed to other States, and will probably have to be dropped.

Our membership can not, therefore, be counted as more than one hundred and eight or ten at most.

Of persons elected members in the last two years, 14 have failed to perfect their membership by the payment of the initiation fee; 18 others elected during the same two years have perfected their membership in that respect.



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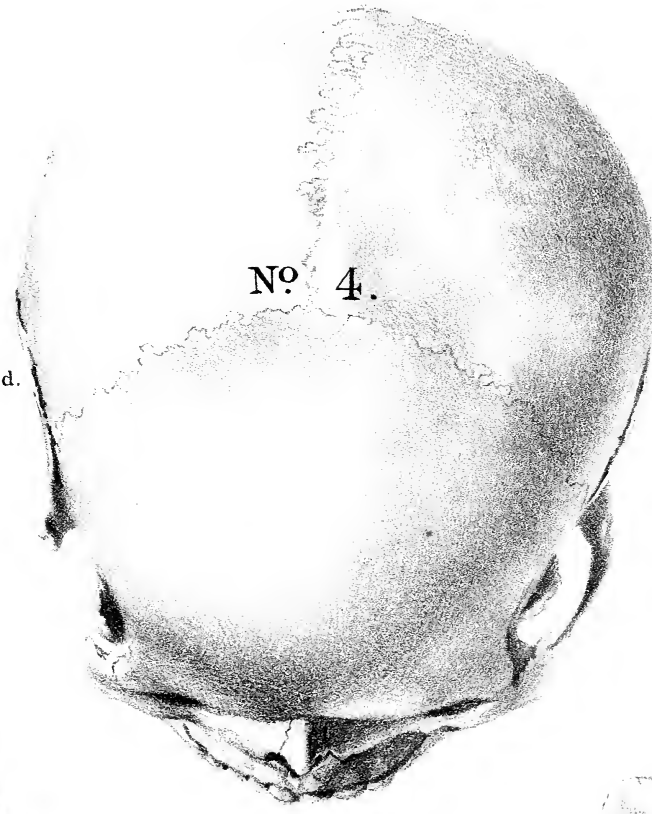

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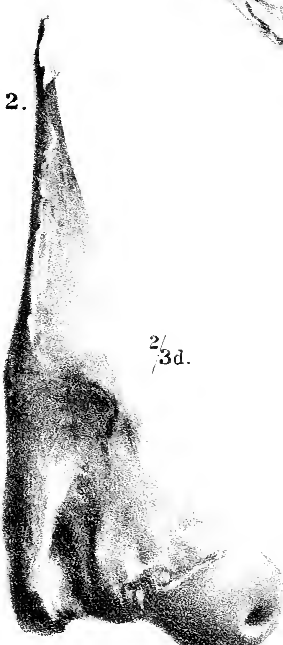

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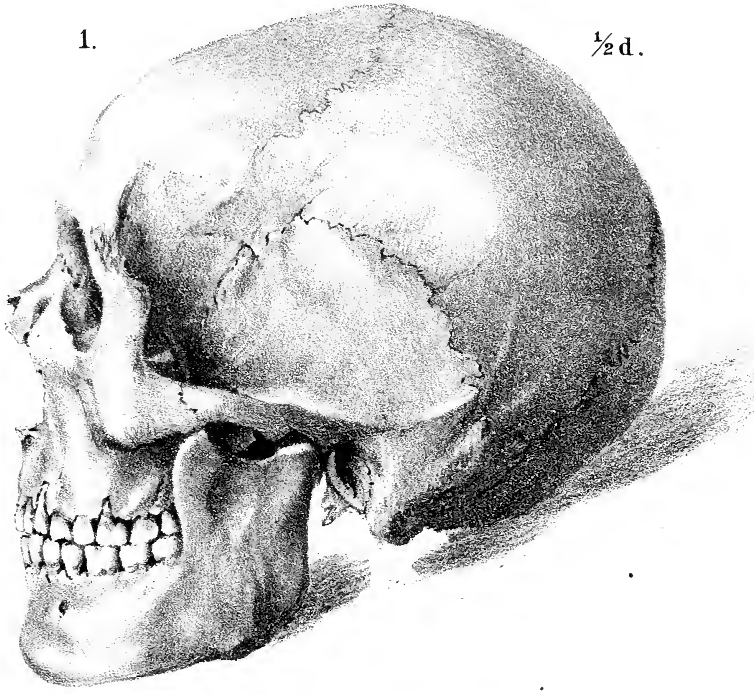

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KREBS LITHOGRAPHING COMPANY, CINCINNATI.

THE JOURNAL

OF THE

CINCINNATI SOCIETY OF NATURAL HISTORY.

VOL. III. CINCINNATI, JULY, 1880. No. 2.

PROCEEDINGS OF THE SOCIETY.

TUESDAY EVENING, MAY 4, 1880.

Dr. R. M. Byrnes, President, in the chair. Present, about 30 members.

Mr. Davis L. James read an exceedingly interesting paper on the fertilization of the common wild flower, the "Spring Beauty," and exhibited specimens of the insect through whose agency the fertilization is accomplished.

The following officers were elected to fill vacancies, viz:

J. W. Hall, Jr., Curator of Mineralogy.

E. M. Cooper, Curator of Conchology.

J. W. Hill and E. D. Huntington were elected to regular membership in the society.

Donations were received as follows:

From Mr. Charles F. Low, a large collection of pre-historic specimens from the Ancient Cemetery near Madisonville, comprising upwards of 200 pieces of pottery, stone, bone, shell and copper implements and ornaments, pipes, flints, etc. Part of which were illustrated in the last number of this Journal.

From Dr. A. E. Heighway, skeletons of an eagle, pelican, wildcat, and an American marmot, or woodchuck.

From Dr. J. H. Hunt, a copy of Kolliker's "Microscopical Anatomy."

From Mr. D. L. James, specimens of a Lichen—*Lecidea albocærulea*—found on the surface of the rocks.

From Mr H. B. Stowe, of the Adams Express Company, two unique specimens of decorated modern Indian pottery, from New Mexico.

From Mr. George Currie, four specimens of mastodon bones.

From Paul F. Mohr, one specimen of the "Hellbender"—*Menopome allegheniensis.*

From Dr. W. A. Dunn, several human bones, from a mound near the mouth of the Great Miami. The bones are encrusted, in part, with carbonate of lime.

TUESDAY EVENING, JUNE 1, 1880.

Dr. R. M. Byrnes, President, in the chair. Present, about twenty members.

Dr. W. A. Dunn read a very instructive essay upon the proper method of examining and excavating mounds, so as to readily distinguish intrusive burials from original interments.

Mr. L. S. Cotton made a few remarks upon the same subject, and suggested, that in excavating a mound, it would be well to lay it off in sections, and commence at one side and completely excavate each section, before commencing work upon the adjoining one.

Mr. Davis L. James read a very interesting letter from Joseph F. James, a corresponding member of the Society, relating his travels in the great Colorado Desert. He described the barrenness of the alkaline plains, the scouring effect of wind-driven sand, and the terrific character of the rain storms, which seldom occur, but when they do come, the water is poured down instead of falling in drops. He also described the scanty vegetation which, being a good botanist, he is so well able to do, and furnished the names of the few plants to be found in that arid region. A few drawings which he had made of the fossil shells found on the desert plains were also shown to the audience.

Prof. A. G. Wetherby described the lithological character of the Trenton Group about Lexington and the High Bridge in Kentucky. He estimated the thickness of the Trenton limestone exposed at High Bridge, and by the railroad cuts within nine miles of that place, at not less than five hundred feet. He exhibited some specimens of *Orthis tricenaria*, *O. pectinella*, *Hybocrinus tumidus*, *Amygdalocystites florealis*, *Glyptocrinus priscus*, *Blastoidocrinus carchariædens*, a

cystidean belonging to a new genus, that he proposed to call *Hybocystites*, and a *Colpoceras*, which he had collected in these rocks.

Mr. S. A. Miller made some remarks upon the Trenton age of the rocks described, as evidenced by the fossils collected in them. The crinoids and cystideans exhibited are the same that are found in the Trenton Group, at Ottawa, Canada. The brachiopods are characteristic of the Trenton Group in New York and Southeastern Missouri, and these cephalopod of the Black River Group of New York. None of these species have ever been found in rocks higher than the Trenton Group, and some of the genera are also confined to the rocks of this age, notwithstanding the great geographical distribution and their well known appearance at points more than one thousand miles apart. He thought from the estimate of the thickness of the Trenton in the limited area, mentioned by Prof. Wetherby, and from other information respecting this group of rocks in Kentucky, that the total thickness of the group in that state may be found to be 800 or 1,000 feet. That the top of the Trenton Group appears in the bed of the Ohio river, opposite that part of Cincinnati called Fulton, that it is here succeeded by rocks of the age of the Utica Slate of New York, about which there can be no doubt, in the mind of any one conversant with the fossils, though, on account of the calcareous character of the strata and their graduation into the well known rocks of the Hudson River Group, which constitute the hills back of the city of Cincinnati, the line of separation between the Utica Slate and the Hudson River Group is not so well determined.

Mr. Alex. McAvoy was elected to regular membership.

Donations were received, as follows:

From Ed. R. Quick, several specimens of fish, crustaceans and reptiles collected in White river, near Brookville, Indiana.

From Geo. L. Murdock, of San Francisco, California, a specimen of *Hippocampus*.

From Prof. A. G. Wetherby, *Leperditia fabulites*, from the Trenton Group at High Bridge, Kentucky.

From a member of the Society, a very large specimen of *Placenticeras placenta*, from the Tombigbee Sand of Alabama.

REPORT IN MEMORY OF ROBERT BUCHANAN.

At the meeting of May 6, 1879, Mr. S. A. Miller moved that Geo. Graham, J. A. Warder and R. B. Moore be appointed to draught a report of respect to the memory of Mr. Robert Buchanan, deceased, which motion was adopted. At the meeting of June 3d, 1879, Mr. Geo. Graham read the following report on behalf of the committee.*

The Committee appointed at the last regular meeting of this Society to prepare an obituary notice of the death, on the 23d of April last, of one of our most distinguished citizens, and a life member of this Society—Mr. Robert Buchanan—ask leave to report:

That the numerous notices given of his death in the public prints, at the time it occurred, and the gloom which was cast over the community by the loss of such a man, is sufficient evidence of the high appreciation of his virtues by the public, and his long life of usefulness in promoting the general good of his fellow men, as well as the prosperity of everything connected with their welfare. It might, therefore, be deemed unnecessary to offer a tribute in this Society, so long after the public announcement of the funeral; but there is a peculiar propriety in acknowledging our respect, love and honor for the memory of those of our associates, whose examples are most worthy of imitation, and whose lives have been in accordance with those pure feelings, which we consider one of the tendencies of our pursuits as members of this society to strengthen and to cherish. We, therefore, feel it a duty incumbent upon us, at this meeting, to record in our proceedings, the death of one whose example we may hold up to the consideration of the rising generation, without fear that it may contain the seeds of bad influence or corruption. A full history of the life of our late member would in part be a repetition of what has been published and already known to our members, we may, therefore, give but a sketch of the various duties and offices held by him during more than sixty years of his life in this community.

Robert Buchanan was born in Westmoreland county, in Pennsylvania, January 15th, 1797. In 1811 he was engaged in a store in Pittsburgh, at that time a city of 5,000 inhabitants. This duty enabled young Buchanan to acquire a training that prepared him for a notable career as a merchant and

*The publication of this report has been inadvertently delayed until the present time.

man of business. About the time this engagement was made he happened to be at Liverpool, Ohio, and was one of the curious crowd that gathered to witness the "Orleans" pass down the river, on her trial trip, being the first steamboat launched on the Ohio river. In 1816 he was in a store in West Union, in which he was a partner, also at Brush Creek furnace, the first establishment of that kind in southern Ohio. He then became one of the pioneers in opening up the present vast iron interest of the Ohio valley. In 1822, having closed up his business in West Union, he acted as Captain of the steamboat Maysville, a small boat plying between Cincinnati and New Orleans.

Leaving the river in 1823, Mr. Buchanan went into the wholesale grocery business with Chas. McAllister, as a partner, on Main and Front streets. This firm was the first in the West to make a specialty of the grocery trade. The city at that time contained about 10,500 inhabitants, while it had but 6,000 inhabitants in 1817. He was President, from 1831 to 1835, of the Commercial Bank, established in Cincinnati after the sweeping crash in 1819. This bank is still in existence. He was one of the commissioners named in the charters to organize the Little Miami and the Ohio and Mississippi Railroad Companies. He also assisted in establishing the Widows' Home, and in organizing several insurance companies, in one of which he served as President. He took a lively interest in the construction of the Whitewater Canal, and for a time was President of the Company. He served for a long period as President of the Cincinnati Historical Society, and also of the Cincinnati Horticultural Society, organized at his house in 1843. He was also, at one time, President of the Western Academy of Natural Sciences at Cincinnati. Soon after the organization of this Society he was one among others who, as members of the Western Academy of Natural Sciences, donated to this Society all its books, money and fossils which now form an important part of our collection. He also, in connection with some friends, transferred his fine collection of botanical specimens, his library and fossils, to this Society. For more than 20 years he was President of the Cincinnati College, and remained President to the time of his death. He was one of the principal movers in projecting the beautiful and famous Spring Grove Cemetery in 1844, and was President of the Board of Directors continuously until his death. In 1861 and 1862 he was President of the Cincinnati, Wilmington and Zanesville Railroad Company.

These and other positions, responsible or complimentary, filled by Mr. Buchanan, during his long and busy career, came to him mainly as a recognition and reward of his far-sighted view of what the future had in store.

He was one of the first of the early settlers to recognize the possibilities of growth possessed by Cincinnati, and was always among the foremost in public enterprise.

In 1825, in company with his business partners, he established a wholesale grocery at Louisville, and a commission house in New Orleans, which were carried on with varying fortune till finally closed by the death or removal of his partners. From 1823 to 1831 he was engaged in pork packing. At different times he was part owner of steamboats, and, with his partners, built several dwelling houses and stores. He built and conducted, with others, the Phœnix Cotton Factory of Cincinnati, and the Covington factory. He was also one of the firm that operated the Cooper Cotton Mill, in Dayton. In company with William Mansar, he leased the Covington Rolling Mill, and operated it successfully for ten years. In 1837 he was engaged by the United States Bank to purchase gold and silver, and in this transaction no security was required, as his well-known integrity was considered a sufficient guaranty.

In 1843, having acquired an extensive knowledge of botany, and anxious to cultivate the native grape and other fruits, he purchased his country seat in Clifton, which he ornamented with choice fruits and flowers, setting an example at that early day of landscape gardening, which has made Clifton the beauty and pride of the people of Cincinnati. His country residence being near Spring Grove Cemetery, he was enabled to devote his leisure hours in attending to the delightful pursuits of horticulture, and with the able supervision, of Mr. Strauch, Spring Grove is placed at the head in beauty and extent of any other cemetery in this country or in Europe.

The great exigencies of times call forth the services of men who seem formed for the difficulties and dangers with which they are surrounded. They achieve the object of their mission and depart. But not alone to those the world calls great is society to look for its valuable members. At all times there are men of strong minds, and well directed views, who are pursuing the even tenor of their way adding to public prosperity and social blessings who do not seem to understand their own importance. They are fulfilling the great objects of life, but the quietness of their course seems to admit of no special distinction, though they leave the world with the vestiges of their labor, in the place where they stood. Wherever they have been are found the tokens of their being. They leave an indelible mark upon the age in which they flourished. In this class the name of Robert Buchanan will be found.

Robert Buchanan commenced a business life in the early part of the

present century, when the great West was taking a place in the commercial history of the country. Cincinnati was the commercial point where business of the West centered. It will be seen, from what we have said, that Mr. Buchanan was a merchant and a manufacturer devoted to the great idea of increasing the commerce of the great valley of the Mississippi. In his life-time he could go back to the scenes of his early childhood, in Pennsylvania, where only a few years before he was born, the whole Allegheny ridge was an unbroken mass of wilderness. Trains of pack horses might be seen climbing the mountain sides by the bridal path, threading the meanders of the valleys and gorges, trembling on the brinks of precipices, and sliding down declivities which scarcely afforded a secure footing to man or beast. They were laden with merchandise for traffic. The conductors were men inured to all the hardships which beset the traveler in the wilderness. Men who united the craft of the hunter to the courage and the discipline of the soldier, for the road they traveled was the war path of the Indian. It was the track that had been beaten smooth by the feet of them that sought the blood of the white men, and who still lurked in the way bent on plunder and carnage. There was no resting place, no accommodations, no shelter. Throughout the day they plodded on through the forest, scaling steep acclivities, fording rivers, enduring all toils of an arduous march, and encamping at night in the wilderness, observing the precaution and the discipline of a military party in a hostile country. These were merchants carrying their wares to the forts and settlements of the West. They were the pioneers of that commerce which now employs the wealth and controls the resources of an empire. In Mr. Buchanan's boyhood, he was acquainted with the O'Haras, the Irwins, the Semples, and others, who were the pioneers in the commerce of the Ohio valley.

In reviewing the life of our late member, and tracing the scenes and adventures of the early pioneers, it may be interesting to some of our young menbers to know that the building which we occupy is on part of the ground formerly occupied as Fort Washington, and using the language of a favorite author, we can compare the early history with the busy scenes of a populous city.

Eighty-five years ago, the national flag waved over a lone fortress, surrounded by a few log huts, on the spot we now occupy. Around it was the unbroken forest, penetrated only by the war path of the Indian and the track of the buffalo. Standing upon the ramparts of that fort, the eye of the beholder would have rested on the pristine verdure of the luxuriant forest, and on the placid stream of the Ohio, seldom disturbed even by the water

craft which then floated on its surface. His ear would have heard at dawn the martial notes of the reveille, and at night the hooting of the owl and the savage bay of the prowling wolf. Now we stand upon the same spot, in the center of a populous city, surrounded by all the refinements of wealth and cultivation. A city numbering, with its suburbs, three hundred thousand souls.

We have stated that Mr. Buchanan was on the steamboat "Maysville," in 1822. In 1817, a few small steamboats were used in transporting merchandise from New Orleans to the upper country; but the use of steam was just commencing. The number of keel-boats employed in the upper Ohio is presumed to have been about one hundred and fifty, averaging thirty tons each, and requiring one month to make a voyage from Louisville to Pittsburg. About twenty barges, averaging one hundred tons each, comprised the whole of the commercial facilities for transporting merchandise from New Orleans to the upper country. Each of these performed one trip down and up again to Louisville and Cincinnati within the year.

The first boats used in the navigation of the western rivers were the flat boat, the keel, and the barge. The first of which was used only in descending with the current, while the two latter ascended the streams, propelled laboriously by poles. Navigating long rivers, whose shores were still infested by hostile savages, the boatmen were armed and depended for safety upon their caution and their manhood.

We have stated that Robert Buchanan was continuously elected President of Spring Grove Cemetery for more than thirty years. An institution which has hundreds of lot-holders entitled to vote annually for the Board of Directors, and yet from the time of its first organization no change occurred in the presidency. In those grounds the Directors have laid the mortal part of our departed friend, and covered it with the sod that nourished those flowers which adorn the grounds, many of which were selected by his own care and taste.

GEO. GRAHAM,
R. B. MOORE, } *Committee.*
JNO. A. WARDER,

NORTH AMERICAN MESOZOIC AND CÆNOZOIC GEOLOGY AND PALÆONTOLOGY.

By S. A. Miller, Esq.

[*Continued from Vol. 3, page 32.*]

Wm. M. Gabb* described, from Eufaula, Alabama, *Fusus holmesanus*, *Cancellaria eufaulensis*, *Dentalium ripleyanum*, *Venus meekana* *Astarte octolirata*, *Trigonia eufaulensis*, *Axinæa rotundata*, *Nucula distorta*, *N. eufaulensis*, *Arca eufaulensis*, now *Nemodon eufaulensis*, *Hamulus major;* from Hardeman county, Tennessee, *Neptunea impressa*, *Fasciolaria saffordi*, *Turritella hardemanensis*, *T. pumila*, *T. saffordi*, *T. tennesseensis*, *Venus ripleyana*, *Corbula subcompressa*, *C. crassiplicata*, *Modiola saffordi*, now *Volsella saffordi*, *Arca saffordi*, *Ostrea crenulimarginata;* from New Jersey, *Rostellaria rostrata*, now *Anchura rostrata*, *Cypræa mortoni*, *Lunatia halli*. *Pholas cretacea*, now *Martesia cretacea*, *Teredo irregularis*, now *Polarthrus irregularis*, *Gastrochæna americana*, now *Polarthrus americanus*, *Isocardia conradi*, now *Opis conradi*, *Modiola ovata*, now *Volsella ovata*, *Leda slackiana*, now *Nuculana slackana*, *Serpula habrogramma*, *Dentalina pulchra*, now *Phonemus pulcher;* from the Indian Territory, near the Choctaw Mission, *Chemnitzia occidentalis;* and from Oregon, *Discoidea occidentalis;* Gabb and Horn described, from Hardeman county, Tennessee, *Platytrochus speciosus;* from Prairie Bluff, Alabama, *Flabellum striatum;* from New Jersey, *Trochosmilia conoidea*, *Acerviclausa vermicularis*, *Heterocrisina abbotti*, now *Bicrisina abbotti*, *Hippothoa irregularis*,† *Cellepora carinata*, now *Reptoporina carinata*, *C. typica*, now *Escharifora typica*, *Reticulipora sagena*, and *Multicrescis parvicella*.

T. A. Conrad‡ described, from Barbour county, Alabama, and Tippah county, Mississippi, *Pholadomya anteradiata*, *P. papyria*, *P. postsulcata*, *Sanguinolaria cretacensis*, *Tellina eufaulensis*, *T. limatula*, *T. eborea*, *Dosina depressa*, now *Cyprimeria depressa*, *D. obliquata*, *Mysia parilis*, now *Tenea parilis*, *Cardium linteum*, now *Cymbophora lintea*, *Crassatella lintea*, *C. pteropsis*, *Linearia metastriata*, *Kellia cretacea*, *Sphærella concentrica*, *Crenella sericea*, *Cucullæa maconensis*, now *Trigonarca maconensis*, *Nucula cunei-*

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* Jour. Acad. Nat. Sci., 2d ser. vol. 4
† Proc. Acad. Nat. Sci.
‡ Jour. Acad. Nat. Sci., 2d ser. vol. 4.

frons, *N. perœqualis*, *Leda longifrons*, now *Nuculana longifrons*, *Venilia trapezoidea*, now *Veniella trapezoidea*, *Cardium eufaulense*, *Dione eufaulensis*, *Astarte crenalirata*, *Corbula eufaulensis*, *Plicatula saffordi*, *P. tetrica*, *Pecten argillensis*, *P. mississippiensis*, *P. simplicius*, now *Syncyclonema simplicium*, *Turrilites spiniferus*. *Anchura abrupta*, *Turritella trilira*, *Daphnella eufaulensis*, *D. lintea*, *D. subfilosa*, *Drillia distans*, *Fusus tippanus*, *Strepsidura ripleyana*, *Volutilithes eufaulensis*, *Actæon modicellus*, *Chemnitzia corona*, *C. melanopsis*, *C. spillmani*, *C. laqueata*, *C. trigemmata*, *Pyropsis perlata*, *Neritella densata*, *Gyrodes alveatus*, *G. crenatus*, *Turbinopsis hilgardi*, *Tuba bella*, now *Spironema bellum*, *Morea cancellaria*, *Thylacus cretaceus*, *Placunanomia saffordi*, *Cassidulus abruptus*, and *C. subquadratus*.

Prof. E. W. Hilgard* subdivided the Cretaceous rocks of Mississippi into four groups as follows : 1. The lowest, the Eutaw Group, as characterized by Tuomey, near Eutaw, Alabama. 2. Tombigbee Sand Group. 3. Rotten Limestone Group. 4. Ripley Group of Conrad.

The Eutaw Group consists of bluish black, or reddish, laminated clays, often lignitic, alternating with, and usually overlaid by non-effervescent sands, mostly poor in mica, and of a gray or yellow tint. It contains beds of lignite, and rarely other fossils. It is displayed at a few places in Tishamingo, Itawamba, Monroe, and Lowndes counties.

The Tombigbee Group is usually a fine-grained micaceous sand, more or less calcareous, usually of a greenish tint, but not unfrequently gray, bluish, black, yellowish and sometimes even orange red. The greenish tint is imparted to these sands not by greensand grains, as is the case in the marls of the Ripley Group, but is caused by a greenish incrustation, covering thinly a portion of the quartz grains, but the presence of glauconite in the incrustation has not been detected. Clays and non-calcareous sands are subordinate to the greenish sand. This Group forms a narrow belt on the western exposure of the Eutaw Group, and extending from Lowndes county through Monroe, Itawamba and Tishamingo, to the southern border of Tennessee.

The Rotten Limestone Group possesses the same characteristics ascribed to it by Tuomey in Alabama, and appears as a soft, chalky rock, of a white or pale bluish tint, with very little sand; consisting of variable proportions of fat, tenacious clay, and white carbonate of lime in crystals extremely minute, and with some shells of infusoria. It is

* Geo. of Miss.

generally highly fossiliferous, and irregular, rounded nodules of iron pyrites of a radiated structure called "sulphur balls" are common. It is of great thickness on its southwestern border in Chickasaw, Octibbeha, Noxubee and Kemper counties, where borings have been made in it from 700 to 1000 feet, but there is a gradual thinning out northward, through Pontotoc, Itawamba, Tippah and Tishamingo counties to the line of Tennessee. The surface area of this subdivision in Mississippi is greater than that of the other three combined.

The Ripley Group forms the border of the western exposure of the Cretaceous, from a point in Chickasaw through the central part of Pontotoc, the eastern part of Tippah and western part of Tishamingo to the south line of Tennessee. It consists of hard crystalline limestone, more or less sandy and glauconitic, which forms the highest strata; and bluish micaceous marls, more or less sandy, and often interstratified with subordinate ledges of sandy limestone, which latter become less and less frequent as we descend in the series toward the strata forming a transition into the Rotten limestone.

Meek and Hayden* described, from (Fort Benton Group) the mouth of Vermilion river, *Ammonites vermilionensis*, now *Mortoniceras vermilionense;* from near the Black Hills, *Scaphites warreni;* from Little Blue river, *Inoceramus aviculoides*, now *I. problematicus*, var. *aviculoides;* from (Fox Hills Group), Moreau river, *Phylloteuthis subovatus*, *Dentalium pauperculum*, now *Entalis paupercula*, and *Cylichna scitula;* from 20 miles below the mouth of Cannon Ball river, *Tellina formosa*, now *Linearia formosa;* from the north branch of Cheyenne river, *Cyprina humilis*, now *Veniella humilis;* and from Long Lake, *Avicula subgibbosa*, now *A. linguiformis*, var. *subgibbosa;* from the mouth of Judith river (Judith river Group), *Helix evansi*, now *Hyalina evansi;* from the mouth of Grand river, *Sphærium planum*, *S. recticardinale*, *Cyrena cytheriformis*, now *Corbicula cytheriformis*, and *Inoceramus subcompressus*, now *I. cripsi*, var. *subcompressus;* from (Fort Pierre Group), the head of the south branch of Cheyenne River, *Helicoceras angulatum*, now *Heteroceras angulatum*, *Ammonites placenta*, var. *intercalaris;* now *Placenticeras placenta*, var. *intercalaris;* from the Yellow Stone river, *Scaphites nodosus*, var. *plenus*, *Aporrhais parva*, now *Anchura parva*, *A. sublaevis*, and *Mactra gracilis;* from Fort Clark, *Teredo selliformis;* from White river, *Inoceramus vanuxemi*, *I. balchi*; from Bijou Hill, *Anomia subtrigon-*

* Proc Acad. Nat. Sci.

alis, and from the great bend of the Missouri river below Fort Pierre, *Ostrea inornata.*

From (Niobrara Group) near the mouth of the Niobrara river, *Anomia obliqua;* from (Dakota Group) near the mouth of the Big Sioux river, *Mactra Siouxensis.* F. B. Meek described, from near Bear river, on Sulphur Creek, *Anomia concentrica*, *Corbula concentrica*, *C. engelmanni*, *C. pyriformis*, and *Melania humerosa*, now *Pyrgulifera humerosa;* from the North Platte, *Inoceramus simpsoni;* from Ham's Fork, northeast of Fort Bridger, *Melampus priscus*, now *Rhytophorus priscus*, *Melania simpsoni*, now *Goniobasis simpsoni*, *M. arcta*, *M. nitidula*, now *Limnæa nitidula*, *L. similis*, *L. vetusta*, *Planorbis spectabilis*, *P. utahensis*, and from near Fort Bridger, *Unio haydeni.* Some of the latter species probably belong to the Lower Eocene.

In 1861, Meek and Hayden,* as before mentioned, separated the Cretaceous rocks of the Missouri region into five subdivisions, in ascending order, as follows:

1. Dakota Group, consisting of yellowish, reddish, and occasionally white sandstone, with, at places, alternations of various colored clays and beds and seams of impure lignite; also silicified wood, and great numbers of leaves of the higher types of dicotyledonous trees, with casts of *Pharella dakotensis*, *Axinaea siouxensis*, and *Cyprina arenarea.* Found at the hills back of the town of Dakota; also extensively developed in the surrounding country in Dakota county, below the mouth of Big Sioux river, thence extending southward into northeastern Kansas and beyond. Estimated thickness, 400 feet.

2. Fort Benton Group, consisting of dark gray, laminated clays, sometimes alternating near the upper part with seams and layers of soft gray and light colored limestone, *Inoceramus problematicus*, *I. tenuirostratus*, *I. latus*, *I. fragilis*, *Ostrea congesta*, *Venilia mortoni*, *Pholadomya papyracea*, *Ammonites mullani*, *A. percarinatus*, *A. vespertinus*, *Scaphites warreni*, *S. larvæformis*, *S. ventricosus*, *S. vermiformis*, *Nautilus elegans*, etc. Extensively developed near Fort Benton, on the Upper Missouri; also along the latter from ten miles above James river to Big Sioux river, and along the eastern slope of the Rocky Mountains as well as at the Black Hills. Estimated thickness, 800 feet.

3. Niobrara Group, consisting of lead-gray calcareous marl, weathering to a yellowish or whitish chalky appearance above, containing

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* Proc. Acad. Nat. Sci.

large scales and other remains of fishes, and numerous specimens of *Ostrea congesta,* attached to fragments of *Inoceramus.* Passing down into light yellowish and whitish limestone, containing great numbers of *Inoceramus problematicus, I. pseudomytiloides, I. aviculoides,* fish scales, etc. Found in the bluffs along the Missouri, below the Great Bend, to the vicinity of Big Sioux River ; also below there on the tops of the hills. Estimated thickness, 200 feet.

4. Fort Pierre Group, consisting of dark beds of very fine unctuous clay, containing much carbonaceous matter, with veins and seams of gypsum, masses of sulphuret of iron, and numerous small scales, fishes local, filling depressions in the bed below. Lower fossiliferous zone, containing *Ammonites complexus, Baculites ovatus, B. compressus, Helicoceras mortoni, H. tortum, H. umbilicatum, H. cochleatum, Ptychoceras mortoni, Fusus vinculum, Anisomyon borealis, Amauropsis paludiniformis, Inoceramus sublævis, I. tenuilineatus,* bones of *Mosasaurus missouriensis,* etc. Middle zone, nearly barren of fossils. Upper part consisting of dark gray and bluish plastic clays, containing, near the upper part, *Nautilus dekayi, Ammonites placenta, Baculites ovatus, B. compressus, Scaphites nodosus, Dentalium gracile, Crassatella, evansi, Cucullæa nebrascensis, Inoceramus sagensis, I. nebrascensis, I. vanuxemi,* bones of *Mosasaurus missouriensis,* etc. Found on Sage creek, Cheyenne river, White river above the Mauvaises Terres, Fort Pierre, and out to Bad Lands, down the Missouri on the high country, to Great Bend and near Bijou Hill on the Missouri. Estimated thickness, 700 feet.

5. Fox Hills Group, consisting of gray, ferruginous and yellowish sandstone and arenaceous clays, containing *Belemnitella bulbosa, Nautilus dekayi, Ammonites placenta, A. lobatus, Scaphites conradi, S. nicolletti, Baculites grandis, Busycon bairdi, Fusus culbertsoni, F. newberryi, Aporrhais americana, Pseudobuccinum nebrascense, Mactra warrenana, Cardium subquadratum,* and a great number of other molluscous fossils, together with bones of *Mosasaurus missouriensis,* etc. Found at Fox Hills, near Moreau river, near Long Lake, above Fort Pierre, along the base of Big Horn Mountains, and on North and South Platte rivers. Estimated thickness, 500 feet.

In Nebraska the sandstones of the Dakota Group rest directly upon rocks of the age of the Upper Coal Measures, or of Permian Age.

They described from the Fort Pierre and Fox Hills Groups, at Deer Creek, near the north branch of the Platte river, *Leda bisulcata,* now *Nuculana bisulcata, Gervillia recta, Crenella elegantula, Cardium pertenue,* now *Protocardia pertenuis, Tellina nitidula,* now *Mactra*

nitidula; from the mouth of the Big Horn river, *Lingula nitida*, and from the head of Gros-Ventres river, *Ostrea gabbana*, and *Cardium curtum*. And from the Fort Union Group, on the Lower Fork of Powder river, *Viviparus reynoldsanus.*

F. B. Meek described, from Vancouver and Sucia Islands, *Dosinia tenuis*, *Inoceramus subundatus*, *Mactra gibbsana*, *Baculites inornatus*, *B. occidentalis*, *Ammonites complexus*, var. *suciensis*, *A. vancouverensis*, and *Nautilus campbelli.*

W. M. Gabb* described, from Crosswicks and other places in New Jersey, *Turritella granulicosta*, *Crassatella transversa*, now *Etea transversa*, *Axinæa subaustralis*, *Ctenoides squarrosa*, now *Lima squarrosa*, *Terebratulina hallana*, *Actæon cretaceus*, *A. ovoideus*, *Natica infracarinata*, *Lunatia altispira*, *Gyrodes obtusivolvus*, *G. abbotti*, *Turbinopsis depressa*, *Architectonica abbotti*, now *Margaritella abbotti*, *Fasciolaria slacki*, *Voluta delawarensis*, *V. kanei*, *V. mucronata*; from Comanche Peak, Texas, *Globiconcha curta*; from Mississippi, *Gyrodes spillmani*, *Ostrea pandiformis*; from Alabama, *Trochus mortoni*, *Gryphæa thirsæ*; from New Jersey, *Teredo contorta*, now *Turnus contortus*, *Anatina elliptica*, now *Periploma elliptica*, *Venilia trigona*, now *Veniella trigona*, *Arca altirostris*, *Cucullæa neglecta*, now *Idonearca neglecta*, *C. transversa*, now *I. transversa*, *Pecten tenuitesta*, *Eudea dichotoma*; and from Tennessee, *Ctenoides denticulicosta*, now *Lima denticulicosta.*

Isaac Lea† described, from Haddonfield, New Jersey, *Corbula foulkei*, *Dosinia haddonfieldensis*, and *Modiola juliæ*, now *Volsella juliæ.*

In 1862, Gabb and Horn‡ described, from Timber Creek and Mullica Hill, New Jersey, *Cellepora prolifica*, *C. exserta*, *C. pumila*, *Reptocelleporaria aspera*, *Escharinella muralis*, *Reptescharellina prolifera*, *Escharipora distans*, *E. abbotti*, *E. immersa*, *Reptescharipora marginata*, *Biflustra torta*, *B. disjuncta*, *Membranipora abortiva*, *M. perampla*, *M. plebia*, *Flustrella capistrata*, *F. cylindrica*, *Reptoflustrella heteropora*, *Retelea ovalis*, *Fascipora americana*, *Spiropora calamus*, *Entalophora*, *quadrangularis*, *E. conradi*, *Diastopora lineata*, *Stomatopora regularis*, now *Alecto regularis*, *Reticulipora dichotoma*, *Crescis labiata*, and from near Yazoo, Mississippi, *Cellepora janewayi.*

Meek and Hayden§ described, from the Fort Benton Group, at

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* Proc. Acad. Nat. Sci.
† Proc. Acad. Nat. Sci.
‡ Jour. Acad. Nat. Sci., 2d ser., vol. 5.
§ Proc. Acad. Nat. Sci.

Chippewa Point, below Fort Benton, on the Upper Missouri, *Scaphites ventricosus*, *S. vermiformis*, *Ammonites mullananus*, *Nautilus elegans*, var. *nebrascensis*, *Inoceramus undabundus*, *I. exogyroides*, *I. tenuirostratus*, *Venilia mortoni*, now *Veniella mortoni*, and *Pholadomya papyracea.*

In 1863, Dr. J. S. Newberry* described, from Orcas Island, *Asplenium elongatum*, *Tæniopteris gibbsi*, and *Ficus cuneatus;* from Vancouver's Island, *Aspidium kennerlyi*, and *Taxodium cuneatum.*

In 1864, W. M. Gabb† described, from Chico creek, California, *Callianassa, stimpsoni*, *Ammonites chicoensis*, *Turritella chicoensis*, *Meretrix lens*, *Dosinia inflata*, *Trochosmilia granulifera;* from Cottonwood creek, and other places in Shasta county, California, *Belemnites impressus*, *Ammonites breweri*, *A. haydeni*, *A. traski*, *A. hoffmanni*, *A. remondi*, *Ptychoceras æquicostatum*, now *Helicaucylus æquicostatus*, *Crioceras remondi*, now *Ancyloceras remondi*, *C. percostatum*, now *A. percostatum*, *Fusus kingi*, *Neptunea curvirostra*, *N. perforata*, *N. hoffmanni*, *Lunatia avellana*, *Ringicula varia*, *Nerinea dispar*, *Acteonina pupoides*, *Pugnellus manubriatus*, *Potamides diadema*, *Turritella infralineata*, *Nerita deformis*, *Anisomyon meeki*, *Actæon impressus*, now *Tornatellæa impressa*, *Turnus plenus*, *Panopæa concentrica*, now *Homomya concentrica*, *Meretrix arata*, *Eriphyla umbonata*, *Lithophagus oviformis*, *Arca brewerana*, and *Leda translucida*, now *Nuculana translucida ;* from Martinez and Clayton, and Canada de las Uva, *Aturia matthewsoni*, *Helicoceras vermiculare*, *Typhis antiquus*, *Fusus martinez*, *F. matthewsoni*, now *Surcula matthewsoni*, *F. aratus*, *F. flexuosus*, *Neptunea gracilis*, *Perissolax brevirostris*, *Buccinum liratum*, now *Brachysphingus liratus*. *Nassa cretacea*, *N. antiquata*, *Pseudoliva lineata*, *Olivella matthewsoni;* from San Diego, *Ammonites cooperi*, *Hemifusus cooperi*, *Neptunea supraplicata*, *Tritonium diegoense*, now *Buccinofusus diegoensis*, *Ancillaria elongata*, *Fasciolaria læviuscula*, *F. sinuata*, *Margaritella crenulata;* from Vancouver Island. *Hamites vancouverensis*, *Solen diegoensis*, *Barbatia morsei;* from Martinez, *Mitra cretacea*, *Morio tuberculatus*, *Lunatia shumardana*, *Naticina obliqua*, now *Catinus obliquus*, *Cinulia matthewsoni;* from Pence's Ranch, Butte county, *Helicoceras breweri*, *H. declive*, *Ptychoceras quadratum*, *Neptunea ponderosa*, *Haydenia impressa*, *Gyrodes conradanus*, *G. expansus*. *Potamides tenuis*, *Martesia clausa*, *Anatina lata;* from Trinity river in Trinity county, *Crioceras latum;* from Fort Tejon, *Fasciolaria io*, now *Surcula io*, *Whitneya ficus*, *Lunatia horni*,

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* Bost Jour. Nat Hist , vol. 7.

† Pal. of California, vol. 1.

L. nuciformis, *Neverita secta*, *Architectonica horni*, *Conus horni*, *C. sinuatus*, now *Surcula sinuata;* from Tuscan Springs, *Fusus averilli*, *Ficus cypræoides*, *Amauropsis oviformis*, *Cinulia obliqua ;* from Mount Diablo and other places, *Fusus diaboli*, *F. californicus*, *Hemifusus horni*, *H. remondi*. *Turris claytonensis*, *T. varicostata*, *Cordiera microptygma*, *Tritonium horni*, *T. paucivaricatum*, *T. whitneyi*, *Pseudoliva volutiformis ;* from Martinez, near Benicia, Tuscan Springs, Texas flat, in Placer county, Clayton, Fort Tejon, Alameda county, Pence's Ranch, Contra Costa county, Rag Canon and other parts of California, *Cinulia pinguis*, *Acteonina californica*, *Globiconcha remondi*, *Cylindrites brevis*, *Niso polita*, *Cerithiopsis alternata*, *Architectonica veatchi*, *A. cognata*, *A. inornata*, *Margaritella globosa*, *Discohelix leana*, *Straparollus paucivolvus*, *S. lens*, *Angaria ornatissima*, *Conus remondi*, *Rimella canalifera*, *R. simplex*, *Pugnellus hamulus*, *Tessarolax distorta*, *Aporrhais falciformis*, now *Anchura falciformis*, *A. angulata*, *A. californica*, *A. exilis*, *Cypræa bayerquei*, *Littorina compacta*, now *Ataphrus compactus*, *Turritella veatchi*, *T. robusta*, *Galerus excentricus*, now *Galeropsis excentricus*, *Spirocrypta pileum*, *Nerita cuneata*, *Lysis duplicosta*, *Dentalium pusillum*, *D. cooperi*, *D. stramineum*, *Emarginula radiata*, *Patella traski*, *Helcion circularis*, *H. dichotoma*, *Bulla horni*, *Cylichna costata*, *Megistoma striatum*, *Solen parallelus*, now *Plectosolen parallelus*, *Pharella alta*, *Corbula primorsa*, *C. traski*, *C. cultriformis*, *C. horni*, *C. parilis*, *Anatina tryonana*, *A. inæquilateralis*, *Pholadomya breweri*, *P. nasuta*, *Neæra dolabriformis*, *Mactra ashburneri*, now *Cymbophora ashburneri*, *Lutraria truncata*, *Asaphis undulata*, *Gari texta*, *Tellina longa*, *T. remondi*, *T. hoffmannana*, *T. monilifera*, *T. ovoides*, *T. matthewsoni*, *T. decurtata*, *T. quadrata*, *T. ashburneri*, *T. parilis*, *T. horni*, *T. californica*, *Venus varians*, *V. veatchi*, *V. lenticularis*, *V. tetrahedra*, *Meretrix horni*, *M. nitida*, *M. longa*, *M. ovalis*, now *Cyprinopsis ovalis*, *Dosinia elevata*, *D. gyrata*, now *Lucina gyrata*, *Tapes conradana*, *T. quadrata*, *Trapezium carinatum*, *Cyprinella tenuis*, *Cardium annulatum*, *C. remondianum*, *C. cooperi*, *C. breweri*, *C. placerensis*, *Cardita horni*, *Lucina nasuta*, *L. postradiata*, *L. subcircularis*, *L. cumulata*, *L. cretacea*, *Loripes dubia*, now *Clisocolus dubius*, *Mysia polita*, *Astarte conradana*, *A. matthewsoni*, *A. tuscana*, *Crassatella grandis*, *Anthonya cultriformis*, *Unio penultimus*, *Mytilus pauperculus*, *M. ascia*, *Modiola ornata*, now *Volsella ornata*, *M. cylindrica*, now *V. cylindrica*, *Septifer dichotomus*, *Crenella concentrica*, now *Stalagmium concentricum*, *Avicula pellucida*, *Inoceramus piochi*, *Pinna breweri*, *Trigonia tryonana*, *Meekia sella*,

M. radiata, M. navis, Arca horni, A. gravida, A. decurtata, Cucullæa matthewsoni, C. truncata, Axinæa veatchi, A. sagittata, A. cor, Limopsis transversa, Pecten traski, P. operculiformis, P. californicus, Lima microtis, L. appressa, Plicatula variata, Ostrea breweri, Exogyra parasitica, Terebratella obesa, Flabellum remondianum, Trochosmilia striata, Astrocœnia petrosa, Ficus mammillatus, now *Ficopsis mammillatus, Natica uvasana, Scalaria matthewsoni, Turritella infra-granulata, Chione angulata,* now *Callista angulata, Tapes cretacea, Cardita veneriformis, Yoldia nasuta, Placunanomia inornata;* from Siskiyou Mountains of Oregon, *Siliqua oregonensis, Tellina whitneyi, Dosinia pertenuis, Modiola siskiyouensis,* now *Volsella siskiyouensis,* and *Ostrea malleiformis.*

In 1865, J. D. Whitney* described the Contra Costa Hills, which consist of a subordinate group of elevations, lying west of Martinez and the San Ramon and Livermore Valleys, and extend through Contra Costa county into Alameda and Santa Clara, and finally become merged in the Mount Hamilton division of the Monte Diablo Range. They are made up of Tertiary and Cretaceous strata, usually but little metamorphosed, although a belt extending along their western side is considerably altered from its original character.

Beginning at the northwest extremity of the group at Martinez, we have in the immediate vicinity of that place Cretaceous strata, well exposed in the bluffs along the Straits of Carquines. Here the rocks observed are sandstones, shales and argillaceous limestones, the latter forming bands and lenticular masses in the shales, generally but a few inches thick, although sometimes as much as three feet. Their strike is usually about N. 42° W, varying, however, from N. 39° W, to N. 44° W, and they dip southwest at an angle of from 35° to 60°. The rocks near Martinez have furnished a great many species of fossils.

In passing along the shore of the Straits of Carquines, west of Martinez, the Cretaceous strata occur for about seven miles, and are made up of shales and sandstones, the former containing frequent thin layers of hydraulic limestone. These rocks exhibit but few fossils. The dip and strike are variable, but generally about east and west magnetic, and the dip is also irregular, but almost always to the southwest, and at almost every angle from nearly horizontal to vertical ; the strike is nearly parallel with the line of the Straits. Near the upper limit of the Cretaceous, are sandstones very like those of Monte Diablo, which accompany the coal, and they contain a considerable quantity of carbonaceous matter, but no regular coal bed, so far as yet discovered.

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* Geology of California, vol. 1.

Near these carbonaceous strata, and above them, is a narrow belt, partly altered and folded, and from 150 to 200 feet in width. The Rodes Valley marks the limit of the Cretaceous going west from Martinez, the Tertiary succeeding in that direction, and resting conformably on the strata beneath, and having the same general southwestern dip. South of Martinez, the Cretaceous strata have a higher dip, but in the same direction.

Near the "Walnut Creek House," a small patch of Cretaceous occurs, extending over a few acres, from which the overlying Tertiary, forming the crown of a low anticlinal, has been denuded.

Monte Diablo is one of the most conspicuous and best known landmarks of California. The central mass is made up of metamorphic rocks; it is about six miles long, and 1½ miles in width, and is surrounded on all sides by entirely unmetamorphosed strata. It is of an irregular crescent form, the concave side turned to the north northeast. It consists essentially of a central portion of very hard metamorphic sandstone, containing considerable epidote, flanked on both sides by jaspers, silicified shales and slates. The former constitutes the north peak, the latter the main peak, on Monte Diablo itself. Along the flanks of the ridge of which Eagle point is the culmination, one may observe the gradual passage of the argillaceous sandstone into the hard dioritic or trappean rock. The strata may be traced in all stages of passage, from the soft sandstone to the hardest and most crystalline rock. On the outside of the great central metamorphic mass, both on the north and south, are heavy accumulations of jaspery rock, one of the most peculiar features of the mountain, and the material of which the culminating point itself is made up. The jasper varies in color from a dull brick red to a brilliant vermillion hue, and may be traced in the ravines in which Bagley creek heads, passing into the unaltered shales of undoubted Cretaceous age, containing *Ammonites Inoceramus*, and other fossils. These jaspers are evidently the result of the alteration of the Cretaceous shales. Gold, copper and cinnabar have been found in these metamorphosed rocks.

The unaltered Cretaceous strata, consisting of shales, sandstones and argillaceous limestone, flank the sides of Monte Diablo, and run out into the plains of the San Joaquin in long, low, and almost parallel ridges. Coal has been found in the shales, but the extensive workable beds are included in the sandstones belonging to the upper part of the Cretaceous. The Arroyo del Puerto, Lone Tree Canon, and Hospital Canon, cut through sandstones and shales of Cretaceous age. The summit of Mount Oso is composed of jaspers, generally dull red,

but often gray and green, with reticulations of quartz, like the rocks of Monte Diablo, and consists of metamorphosed Cretaceous rocks.

North of the mouth of San Luis creek the strata consist of conglomerates, sandstones and shales of Cretaceous age. The conglomerates generally form the crests of the ridges, and are very coarse, containing numerous boulders from one to two cubic feet in size. These consist of porphyry, granite, and various forms of metamorphic rock, entirely unlike the metamorphic Cretaceous of the center of the chain.

The jaspery beds of Chisnantuck are the exact counterpart of those of Monte Diablo, which we know to be Cretaceous, and those of Mine Hill, which contain the deposits of cinnabar, are evidently the continuation of those of Mount Chisnantuck. And as we trace them farther north, to the extremity of the peninsula, we find them still retaining the same lithological character, while we have there the evidence of fossils to prove them to belong to the Cretaceous epoch. Deposits of cinnabar have been found in rocks of Triassic and Tertiary age, but the large and valuable deposits are in the Cretaceous.

The larger portion of the rocks which make up the north end of the peninsula of San Francisco, are Cretaceous. The rocks in the vicinity of Clear Lake, when not of volcanic origin, are Cretaceous, and are the continuation of a great belt of strata of this age, which commences at Benicia, and stretches off to the northwest for an indefinite distance, apparently coming out to the ocean in the neighborhood of Cape Mendocino. The termination of the Coast Range at Benicia is of unaltered Cretaceous strata, much broken, and forming rounded hills, destitute of trees. Here as in Contra Costa county, the Cretaceous is well represented both by the bluish clay shales, with interstratified beds of argillaceous limestone, and by the overlying masses of blue and yellow sandstones, the latter in very heavy beds.

The Cretaceous formation, which is seen cropping out near the northern base of the twin sisters, is continuous from that place as far north as Capel Valley, at which point it becomes metamorphic and broken. The hills lying between the Sacramento and Suisun Valleys are of this age, and appear to form a line of foot hills along a high Cretaceous ridge, made up of unaltered shales and sandstones, running nearly northwest and southeast, and extending from Suisun Bay to Puta Creek. This range is about 3,500 feet high, and the ridge along the summit is formed by heavy bedded sandstones.

Cretaceous strata, in the San Emidio Canon, are seen resting on the granite and upturned edges of the mica and hornblende slates. At the Canada de los Alisos, which debouches into the plain four miles east

of the Las Uvas Canon, the Cretaceous belt is over a mile wide, and forms hills about 1,000 feet above the plain.

The base of the foot hills of the Sierra Nevada is bordered, for a large part of the distance, between Tejon Pass and the head of the Sacramento Valley, by a series of beds of stratified Cretaceous materials resting apparently undisturbed, and in a nearly horizontal position, on the upturned edges of the metamorphic slates and granitic rocks of which the foot-hills are formed. These materials, however, are not seen farther south than Folsom. Good exposures may be seen on Butte and Chico creeks. On the north side of the Cottonwood, beginning at Horsetown, and extending west to the Coast Ranges, Cretaceous strata lie at the base of the mountains, and form a table-land about 1,200 feet high, and have generally a southeasterly dip. Cottonwood creek runs nearly south from the summit of the Siskiyou Mountains to the Klamath river, a distance of 13 miles. The valley of which is about 10 miles long, and is excavated in the softer and unaltered Cretaceous strata, having on either side harder rocks, namely the auriferous slates on the west, and the modern volcanic on the east.

Dr. Joseph Leidy* described, from New Jersey, *Crocodilus tenebrosus*, *C. obscurus*, now *Holops obscurus*, *Cœlosaurus antiquus*, *Tomodon horrificus*, now *Diplotomodon horrificus*, *Chelone sopita*, now *Osteopygis sopitus*, *Emys firmus*, now *Agomphus firmus*, *E. beatus*, now *Adocus beatus*, and *Bothremys cooki;* from Maryland, *Astrodon johnstoni;* and from Minnesota, *Piratosaurus plicatus.*

T. A. Conrad,† from New Jersey, *Ostrea tuomeyi*, *Mortonia turgida*, and *Volutilithes lioderma*, now *Leioderma lioderma.*

In 1866, T. A. Conrad‡ described, from Alabama, *Diploschiza cretacea*, and *Terebratulina filosa.*

Prof. E. D. Cope§ described, from the greensand two miles south of Barnesboro, Gloucester county, New Jersey, *Lælaps aquilunguis*, and from Camden county, *Aturia paucifex.*

In 1867, Prof. F. V. Hayden‖ referred the rocks at Yankton, the capital of Dakota Territory, located on the Missouri, about twelve miles above the mouth of the James, to the yellow, calcareous marl beds of No. 3, of the Niobrara division of the Cretaceous. The same rocks were found at Fort James, about twelve miles below the mouth of Firesteel creek, a branch of the James, and their thickness

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* Cret. Reptiles, U. S., vol. 14, Smithsonian Contributions.

† Proc. Acad. Nat. Sci.

‡ Am. Jour. Conch., vol. 2.

§ Proc. Acad. Nat. Sci.

‖ Am. Jour. Sci. and Arts, 2d ser., vol. 43.

estimated at from 80 to 100 feet, underlaid by No. 2 of the Niobrara division. The entire surface of the country, from the latter place, in northeastern Dakota, to Fort Dakota, at Sioux falls, on the Big Sioux river, is referred to the Cretaceous.

Prof. E. D. Cope* described, from Camden county, New Jersey, *Euclastes platyops*, and *Thoracosaurus brevispinus*, now *Holops brevispinus*.

The Cretaceous rocks occupy a belt or strip of country in New Jersey† which stretches obliquely across the State, from Raritan bay on the northeast, to the head of Delaware bay on the southwest. The extreme length of the formation, from the highlands of Navesink to the Delaware, above Salem, is about 100 miles. Its breadth at the northeast end, from Woodbridge to Deal, is 27 miles, and at the southwest end, from the mouth of Oldman's creek to Woodstown, it is 10¾ miles. The area included in this formation is about 1,500 square miles.

It is subdivided in ascending order, as follows:

1. Plastic clays, 210 feet.
2. Clay marls, 277 feet.
3. Lower marl bed, 30 feet.
4. Red sand, 100 feet.
5. Middle marl bed, 45 feet.
6. Yellow sand, 43 feet.

Total thickness, 705 feet.

The kaolin, which is dug so extensively, belongs to the plastic clay of the above subdivision. It is a very fine micaceous sand, with some fire-clay intermixed, and streaks of clay passing through it. It is of a bluish-white color, sandy in consistency when drained, but pasty when worked up in water.

Prof. E. D. Cope‡ described, from New Jersey, *Osteopygis emarginatus*, *Clidastes iguanavus*, *Nectoportheus validus*, *Emys petrosus*, now *Agomphus petrosus*, *Elasmosaurus orientalis*, and from the Niobrara Group, near the boundary line between Kansas and Colorado, a short distance north of the Smoky Hill fork of the Kansas river, *E. platyurus*.

Dr. Joseph Leidy described, from near Fort Hays, Kansas, *Ptychodus occidentalis*, and from the Judith River Group, *Aublysodon mirandus*, now *Aublysodon horridus*.

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* Proc. Acad. Nat. Sci.
† Geo. of New Jersey, 1868.
‡ Proc. Acad. Nat. Sci.

Prof. Leo Lesquereux* described, from the Dakota Group, north of Fort Ellsworth, Nebraska, or its vicinity, *Pterophyllum haydeni*, *Glyptostrobus gracillimus*, *Sequoia formosa*, *Phyllocladus subintegrifolius*, *Arundo cretaceus*, *Liquidamber integrifolium*, *Populus lancastriensis*, *Populites elegans*, *P. flabellata*, *P. salisburyæfolia*, *P. ovata*, now *Ampelophyllum ovatum*, *P. quadrangularis*, now *Hamamelites quadrangularis*, *Salix proteæfolia*, *Betula beatriciana*, *Fagus polycladus*, *Quercus primordialis*, now *Dryophyllum primordiale*, *Q. hexagona*, *Q. ellsworthanus*, *Q. anceps*, now *Diospyros anceps*, *Q. semialatus*, now *Anisophyllum semialatum*, *Ficus* (?) *rhomboideus*, now *Phyllites rhomboideus*, *Ficus* (?) *fimbriatus*, now *Eremophyllum fimbriatum*, *Platanus aceroides*, var. *latior*, *P. obtusiloba*, *P. diminutivus*, *Credneria leconteana*, now *Protophyllum leconteanum*, *Laurus macrocarpus*, *Sassafras mudgei*, *S. subintegrifolium*, *Lyriodendron giganteum*, *L. intermedium*, *Magnolia tenuifolia*, *Dombeyopsis obtusiloba*, now *Menispermites obtusilobus*, *Negundoides acutifolia*, *Paliurus membranaceus*, *Rhamnus tenax*, *Phyllites rhoifolius*, *Phyllites amorphus*, *P. umbonatus*, and *Prunus cretaceus*.

In Tennessee,† wherever the Cretaceous rocks are exposed, they lie upon Palæozoic strata. They are subdivided into, first, Coffee Sand Group ; second, Green Sand Group, or the shell bed; and third, Ripley Group.

The Coffee Sand Group derives its name from the exposure at Coffee Landing, on the Tennessee river. It outcrops in Hardin and Decatur counties, and overlaps the Western beveled edge of the older rocks. Its outcrop occupies a belt of territory varying from two to eight miles in width, and running more than half way through the State. It has a maximum thickness of about 200 feet. It consists mostly of stratified sands, usually containing scales of mica. Thin leaves of dark clay are often interstratified with the sand, the clay leaves occasionally predominating. Sometimes beds of dark laminated or slaty clay of considerable thickness, from one to twenty feet or more, are met with in the series. It very generally contains woody fragments and leaves, converted more or less into lignite. Silicified trunks of trees are not uncommon. When it passes under Green Sand it becomes the reservoir which yields water when pierced by the well-borers. It is the equivalent of the Tombigbee Sand of Hilgard in Mississippi.

Fossil shells are so abundant in the Green Sand, at some points, that they are gathered by car loads and burned into lime. The maxi-

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* Am. Jour. Sci. and Arts, 2d ser., vol. 46.
† Geo. of Tenn., 1869.

mum thickness ascertained from data, furnished by well-borers, is 350 feet. Its outcrop occupies a belt of the surface averaging about eight miles wide for at least half way through the State. This Group is the northern extension of the rotten limestone of Mississippi and Alabama.

The Ripley Group occupies a belt of the surface along the Memphis and Charleston Railroad about fifteen miles wide, but having a less average width across the State. The high ridges dividing the waters of the Tennessee and Mississippi rivers lie mostly within its area. It has a thickness of 400 or 500 feet, and is mostly made up of stratified sands, though occasionally an interstratified bed of dark, slaty clay, 10 to 30 feet in thickness, occurs, or more frequently a sandy bed laminated with clayey leaves. The hills about Purdy, in McNairy, and about Lexington, in Henderson county, show these rocks well; but more interesting sections, on account of the fossils they contain, are found in Hardeman, near the M. & C. R. R.

In 1869, J. D. Whitney* divided the Cretaceous formation, which is found covering large areas on the west coast, from Vancouver and the adjacent islands of San Juan Archipelago on the north, through Washington Territory and Oregon to Southern California, as well as isolated patches in Eastern Oregon and in Mexico, into four groups, as follows:

1. The Tejon Group, the most modern member, is peculiar to California. It is found most extensively developed in the vicinity of Fort Tejon and about Martinez. From the latter locality it forms an almost continuous belt in the Coast Ranges to Marsh's, fifteen miles east of Mt. Diablo, where it sinks under the San Joaquin Plain. It is also found at various points on the eastern face of the same range, as far south as New Idrea, and in Mendocino county, near Round Valley, the latter locality being the most northern point at which it is yet known. It is the only coal-producing formation in California.

This group contains a large and highly characteristic series of fossils, the larger part peculiar to itself, while a considerable percentage is found extending below into the next group, and several species still further down into the Chico Group. Mr. Gabb considered it as the probable equivalent of the Maestricht beds of Europe.

2. The Martinez Group, which includes a series of beds, of small geographical extent, found at Martinez and on the northern flank of Monte Diablo.

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* Pal. of Cal., vol. 2.

3. The Chico Group, one of the most extensive and important members of the Pacific coast Cretaceous. It is on the horizon of either the upper or lower chalk of Europe, and probably the equivalent of both. It is extensively represented in Shasta and Butte counties, and in the foot-hills of the Sierra Nevada, as far south as Folsom, occurring, also, on the eastern face of the coast ranges, bordering the Sacramento valley at Martinez, and again in Orestimba canon, in Stanislaus county. It includes all of the known Cretaceous of Oregon, and of the extreme northern portion of California, and is the coal-bearing formation of Vancouver's Island.

4. The Shasta Group, including all below the Chico Group. It contains fossils seemingly representing ages, from the Gault to the Neocomien, inclusive, and is found principally in the mountains west and northwest of the Sacramento valley. Two or three of its characteristic fossils have been found in the vicinity of Monte Diablo, and one of the same species has been collected in Washington Territory, east of Puget Sound. Few, or none, of its fossils are known to extend upward into the Chico Group.

W. M. Gabb* described, from Shasta county, from Martinez, Benicia, Colusa county, Tejon, and other places in California, *Philoteuthis foliatus*, *Belemnites impressus*, *Ammonites jugalis*, *A. stoliczkanus*, *A. fraternus*, *Ancyloceras lineatum*, *Diptychoceras laeve*, *Fusus tumidus*, *F. occidentalis*, *Neptunea cretacea*, *N. mucronata*, *Palæatractus crassus*, *Surcula præattenuata*, *S. inconspicua*, *Heteroterma trochoidea*, *Bela clathrata*, *Cordiera mitræformis*, *Tritonium californicum*, *T. tejonense*, *T. fusiforme*, *Brachysphingus sinuatus*, *Bullia striata*. *Turbinella crassitesta*, *Urosyca caudata*, *Neverita globosa*, *Ampullina striata*, *Terebra californica*, *Cypræa mathewsoni*, *Anchura transversa*, *A. carinifera*, *Helicaulax bicarinata*, *H. costata*, *Loxotrema turrita*. *Atresius liratus*. *Turritella martinezensis*, *Nerita triangulata*. *Calliostoma radiatum*, *Ataphrus crassus*, *Margaritella angulata*, *Acmæa tejonensis*, *Aetæonella oviformis*, *Liocium punctatum*, *Ringinella polita*, *Solen cuneatus*, *Anatina quadrata*, *Pholadomya oregonensis*, *Pleuromya papyracea*, *Arcomya undulata*, *Mactra tenuissima*, *Asaphis multicosta*, *Tellina undulifera*, *Donax latus*, *Venus aequilateralis*, *Meretrix fragilis*. *Thetis elongata*, *Cardium translucidum*, *Crassatella compacta*, *Unio hubbardi*. *Modiola major*, now *Volsella major*, *Meleagrina antiqua*, *Inoceramus elliotti*, *I. whitneyi*, *Trigonia aequicostata*, *Nucula solitaria*, *Pecten martinezensis*, *P. complexicosta*, *P. interradiatus*. *Neithea grandicosta*, *Lima shastaensis*,

* Pal. of Cal., vol. 2.

L. multiradiata, Anomia vancouverensis, Ostrea idriaensis, O. appressa, Rhynchonella whitneyi, Smilotrochus curtus.

And from the Sierra de las Conchas. near Arivechi, Sonora, Mexico. *Fusus mexicanus, Euspira tabulata, Chemnitzia zebra, Tylostoma mutabile, Anchura monilifera, Cerithium mexicanum, Angaria cingulata, Cinulia rectilabrum, Pholadomya sonorensis, Cardium sabulosum, C. granuliferum, Cardita alticosta, Remondia furcata, Cucullæa inermis, Gryphæa mucronata.*

Prof. E. D. Cope* described, from Raritan bay, *Ornithotarsus immanis;* from Western Kansas, *Macrosaurus proriger*, now *Liodon proriger;* from Sampson county, North Carolina, *Hypsibema crassicauda, Hadrosaurus tripos*, and *Polydectes biturgidus;* from New Jersey,† *Mosasaurus maximus*, and from Alabama, *Clidastes propython.*

Prof. O. C. Marsh‡ described, from the greensand marl, near Hornerstown, Monmouth county, New Jersey, *Mosasaurus copeanus, M. miersi, M. princeps, Halisaurus fraternus*, now *Baptosaurus fraternus*, and *H. platyspondylus*, now *B. platyspondylus.*

Prof. Leo Lesquereux§ described, from the Dakota Group, at Fort Ellsworth, Nebraska, *Populites microphyllus, Phyllites betulæfolius, Persea nebrascensis*, now *Laurus nebrascensis*, and *Sassafras leconteanum*, now *Persea leconteana.*

The Cretaceous is the lowest formation exposed in Louisiana,‖ and it comes to the surface only at the limestone hills of St. Landry and Winnfield. The borings that have been made for salt, however, show that it is more that 1,000 feet in thickness. The strata are saline, and pure beds of rock salt sometimes occur.

The Cretaceous rocks have been observed in Plymouth, Woodbury, Cass, Guthrie, Pottawattamie, Montgomery, Carroll and Greene counties,¶ Iowa. In all but the first two they appear as outliers. On account of the drift which covers the western half of this State, the area of the Cretaceous has not been determined. The exposure in Plymouth and Woodbury counties extends into Dakota, and belongs to the Dakota Group. The maximum thickness as far as observed is 350 feet. The rocks rest unconformably upon the coal measures beneath, and have a northwesterly dip, while the palæozoic strata dip southwesterly.

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* Proc. Amer. Phil. Soc.
† Proc. Bost. Soc. Nat. Hist.
‡ Am. Jour. Sci. and Arts, 2d ser., vol. 48.
§ Trans. Am. Phil. Soc., vol. 13.
‖ Geo. of Lou., 1870.
¶ Geo. Sur. Iowa, 1870.

In 1870, Dr. Joseph Leidy described, from Middle Park, Colorado,* *Pœcilopleuron valens;* from Pickens county, Alabama, *Clidastes intermedius;* from Kansas, *Xiphactinus audax,* and from the Moreau river, *Nothosaurops occiduus.*

Prof. E. D. Cope† described, from the Green Sand of New Jersey, *Adocus agilis*, *A. pectoralis*, *A. syntheticus*, *Emys turgidus*, now *Agomphus turgidus*, *Bottosaurus tuberculatus*, *Catapleura repanda*, *Osteopygis chelydrina*, now *Catapleura chelydrina*, *Hyposaurus fraterculus*, now *Gavialis fraterculus*, *Holops cordatus*, *H. glyptodon*, *Lælaps macropus*, *Liodon congrops*, *L. perlatus*, *Lytoloma angusta*, *L. jeanesi*, *Mosasaurus depressus*, *M. fulciatus*, *M. maximus*, *M. oarthrus*, *Osteopygis platylomus*, *Peritresius*, *Platecarpus tympaniticus*, *Pneumatarthrus peloreus*, *Taphrosphys lesleyanus*, *T. longinuchus*, *T. molops*, *T. nodosus*, and *T. strenuus.*

He described, from the Niobrara Group, at a point six miles south of Sheridan, Kansas, *Liodon mudgei*, now *Platecarpus mudgei*, *Clidastes cineriarum*, *Saurocephalus prognathus*, *Ichthyodectes ctenodon;* from the north bank of Smoky Hill river, thirty miles east of Fort Wallace, Kansas, *Liodon ictericus*, now *Platecarpus ictericus;* from twenty miles east of Fort Wallace, *Saurocephalus phlebotamus;* from near Fort McRae, in New Mexico, *Liodon dyspelor*, from the bank of Solomon's river, in Kansas, 160 miles from its junction with the Kansas river, *Saurocephalus thaumas*, now *Portheus thaumas.*

Prof. O. C. Marsh,‡ from Green Sand near Barnsboro, New Jersey, *Hadrosaurus minor*, *Mosasaurus crassidens;* from Hornerstown, *Liodon laticaudus;* from Birmingham, *Laornis edvardsanus;* and also from the Green Sand of New Jersey,§ *Palæotringa littoralis*, *P. vetus*, *Telmatornis affinis*, *T. priscus.*

T. A. Conrad‖ described, from Crosswicks, New Jersey, *Inoceramus peculiaris*, *Crassatella prora*, now *Etea prora*, *Trigonarca passa*, *Goniosoma inflata*, *Axinea mortoni*, *Cyprimeria spissa*, *Dentalium falcatum;* and from Haddonfield, *Nucularia papyria*, *Scambula perplana*, now *Anthonya perplana*, *Gouldia decemnaria*, *G. declivis*, *Nemoarca cretacea*, *Trigonarca cuneiformis*, *Perrisonota protexta*, *Camptonectes bellisculptus*, *Liroscapha squamosa*, *Cancellaria subalta*, *Eulima cretacea*, *Gadus obrutus*, *Donax fordi;* from Mississippi,

* Proc. Acad. Nat. Sci.
† Trans. Am. Phil. Soc. Ext. Batr. Reptilia N. Am.
‡ Proc. Acad. Nat. Sci.
§ Am. Jour. Sci. and Arts, 2d ser., vol. 49.
‖ Am. Jour. Conch., vol. 5.

Gemma cretacea; and from Haddonfield, New Jersey,* *Æora cretacea, Tenea parilis, Ænona papyria, Venilia elevata,* now *Veniella elevata, Cardium dumosum,* and *Solyma lineolatus.*

In 1871, Prof. F. B. Meek† said, the oldest beds of the Bear river country of Utah and Wyoming, properly belonging to the Tertiary, (they are now regarded as Cretaceous), and so intimately related to the latest Cretaceous, contain species of *Corbula, Cyrena (Corbicula),* perhaps *Ostrea,* and a univalve related to *Melampus,* directly associated with several species of *Goniobasis,* two of *Unio,* one or two of *Melantho,* several species of *Viviparus,* one of *Tiara,* etc., showing clearly that these strata were deposited in brackish waters. These shells also exist in great numbers, and are preserved in a condition, showing that they could not have been transported far by currents, but that they must have lived and died, at least, near where we now find them.

All palæontologists are aware of the fact, that the remains of fresh and brackish water shells do not generally present such well marked peculiarities of form, ornamentation, etc., in beds of different ages, as we see in marine types, so that they can not always be relied upon, with the same degree of confidence in identifying strata, that we place in marine forms; some of those from oldest Cretaceous being, for instance, very similar to existing species. So far as I have been able to compare the species from this formation with described forms from other parts of the world, they generally agree most nearly with Lower Eocene types; the *Corbicula* and *Tiara* being very similar to forms found in the lower lignites of the Paris basin, and at the mouth of the Rhone in France. At the same time it is worthy of note, that most of these shells are quite unlike any of the known existing North American species, and one of them (*Tiara humerosa*) belongs even to a genus entirely unknown among the existing *Melania* of the American continent, though found inhabiting the streams of Madagascar, the Fejee Islands, etc. One of the *Uniones* (*U. belliplicatus*) resembles in its ornamentation some of the South American species, and the genus *Castalia,* much more nearly than it does any of the recent North American species, although having the form and hinge of a true *Unio;* and another abundant bivalve, found in the same association, *Corbula (Anisothyris) pyriformis,* seems to be allied in some respects to a peculiar group recently described from a Pliocene or Miocene formation, on the Upper Amazon of South America, by Mr. Gabb, under the

* Am. Jour. Conch., vol. 6.

† Advance pamphlet from Hayden's U. S. Geo. Sur. of Wyoming, etc.

name *Pachydon*, and afterward renamed *Anisothyris* by Mr. Conrad, because the name *Pachyodon* had been previously used for another genus.

Of course, comparisons of the shells, from this formation with those of the Tertiary beds of the Atlantic and Pacific slopes, afford no aid whatever in fixing its precise position in the series, because the species from the latter are, almost without exception, marine types. There is less difficulty, however, in drawing parallels between it and the Tertiary deposits of the Upper Missouri country, by a comparison of fossils, although the species are mainly different, so far as yet known, in these two districts. At least two of the known forms, however, from the Utah and Wyoming beds under consideration, are believed to be specifically identical, with species found in the oldest beds, referred to the Tertiary at the mouth of the Judith river, on the upper Missouri, under the name of the Fort Union Group. These are *Unio priscus*, and *Viviparus conradi*. In addition to this, the fossils at these two localities are in precisely the same state of preservation, and have a more ancient appearance than those of the later deposits of both districts, while they also agree exactly in their mixture of brackish and fresh water characters. Again, at both localities, these deposits are intimately associated, as already stated, with what appears to be the latest of the Cretaceous series; while in both districts they contain lignite, and are succeeded by later Tertiary beds of strictly fresh water origin.

He described,* from the Fort Pierre Group, near the great bend in the Upper Missouri,* *Isocardia hodgei*, now *Procardia hodgei*.

Prof. O. C. Marsh† named, from the Niobrara Group, on the North Fork of the Smoky river in Kansas, *Edestosaurus dispar*, now *Clidastes dispar*, *E. velox*, now *C. velox*, *Clidastes pumilis*, *C. wymani*, and *Pterodactylus oweni*.‡

Prof. E. D. Cope described,§ from the Niobrara Group, near Fossil Spring canon, *Edestosaurus stenops*, now *Clidastes stenops*. *E. tortor*, now *C. tortor*, *Holcodus coryphæus*, now *Platecarpus coryphæus*, *Liodon curtirostris*, now *P. curtirostris*, *L. glandiferus*, now *P. glandiferus*, *Portheus molossus*, *P. angulatus*, now *Erisichthe angulatus* ; from Butte creek, *Holcodus tectulus*, now *Platecarpus tectulus*, *Protostega gigas* ; and from one mile southwest of Sheridan, near the Gypsum Buttes, *Liodon latispinus*, now *Platecarpus latispinus*.

* Proc. Acad. Nat. Sci.
† Am. Jour. Sci. and Arts, 3d series, vol. 1.
‡ Proc. Acad. Nat. Sci.
§ Proc. Am. Phil. Soc.

In 1872, Prof. E. W. Hilgard* showed that the Cretaceous of Alabama and Mississippi has a dip sensibly at right angles to the trend (*i.e.*, between W. and S.) at the rate of 20 to 25 feet per mile. That the lower division, called the Coffee Group, or the Eutaw Group is from 300 to 400 feet thick, and consists of noncalcareous sands, and blue or reddish laminated clays, with occasional beds of lignite, and rarely marine fossils, silicified, as at Finch's Ferry in Alabama. This group corresponds with Hayden's Dakota Group, and in its upper part, as at Finch's Ferry, probably with the Fort Benton Group.

The Middle or Rotten Limestone Group is not less than 1,200 feet in maximum thickness, consisting of soft, mostly somewhat clayey, whitish, micro-crystalline limestones, and calcareous clays; very uniform on the whole, with the exception of the locally important feature of the "Tombigbee Sand." The Cretaceous area of Arkansas, according to Owen's description, seems to fall within this group, as does also the greater part of the Cretaceous area of middle and northern Texas.

The Ripley Group consists of crystalline, sandy limestones, alternating with dark-colored glauconitic marls, containing finely preserved fossils, and has a thickness of 300 to 350 feet. It is the equivalent of the highest Cretaceous beds of New Jersey, and of the Fox Hills Group of the West. The series of isolated Cretaceous outliers, which traverse Louisiana, from the head of Lake Bisteneau, in a S. S. E. direction to the great salt mass at Petite Anse, belong to this Group.

Prof. F. V. Hayden† said, that in Nebraska, the sandstones of the Dakota Group rest directly upon rocks of the age of the Coal Measures. Although they do not appear in full force until we reach a point near De Soto and beyond, yet remnants of the sandstones make their appearance within five or ten miles of Omaha, at any point north of the Platte river. It is quite probable that they once extended all over Nebraska, passing across into Iowa, and further eastward. The Coal-measure limestones are thus exposed, in northeastern Nebraska, by the erosion of the Cretaceous rocks.

Near the entrance of the Big Sioux river, into the Missouri, the Dakota Group disappears beneath the water-level, and is succeeded by a series of black, plastic, laminated clays, with lighter-colored arenaceous partings and thin layers of sandstone. Near the mouth of the Vermilion river the upper portion becomes more calcareous, and gradually passes up into the next group, called the Fort Benton Group. It is often immensely thickened, in the vicinity of the mountains, from the north

* Proc. Am. Ass. Ad. Sci.
† Hayden's U. S. Geo. Sur. of Wyoming.

line to New Mexico, but on the Lower Missouri, where it was first observed by geologists, it never reaches a thickness of more than 150 or 200 feet. In New Mexico it occurs as the most conspicuous of the Cretaceous divisions, and along the line of the Kansas Pacific Railway, in Kansas, it has yielded large quantities of the most remarkable reptilian remains.

The Niobrara Group is found, in some form, wherever the Cretaceous beds occur, from the north line to New Mexico, and probably much farther. As it is developed on the Lower Missouri, and southward through Nebraska, Kansas, into Texas and the Indian Territory, it contains thick, massive beds of chalky limestone. On the Kansas Pacific Railway, at Forts Hays and Wallace, this limestone is sawed into blocks of any desirable size, with a common saw, and used for building purposes; but along the flanks of the mountains, or in the far west, it never reveals its chalky character. It is found in thin, slaty, calcareous layers, but universally characterized by the presence of the oyster *Ostrea congesta*, and also some form of *Inoceramus*, or a few fish remains, but the little oyster is ubiquitous. In these three divisions there seems to be no well-marked line of separation, and the more we study them the more intimately do they seem to be blended together.

The Fort Pierre Group begins to overlap the Niobrara Group below the mouth of the Niobrara, and above that point, although the river cuts deep down into the chalk limestone, and long lines of cone-like bluffs extend up nearly to the Great Bend, yet the distant hills on either side of the river show plainly the dark shaly clays of this group. This group covers a vast area of country, perhaps 5,000 square miles or more, and wherever it prevails, it gives to the surface the aspect of desolation. The entire thickness of the group is filled with the alkaline material, which is so well known in the west, and wherever the water accumulates in little depressions and evaporates, the surface is covered with a deposit of the salt varying from an inch to several inches in thickness. The water that flows through these clays is usually impregnated with these salts and thus rendered unfit for use. Although these clays seem to be so sterile, and in the dry season are typical of extreme aridity, yet they are by no means destitute of vegetation. The various species of *chenopodiaceous* shrubs and herbs, that are peculiar to the west, find their natural habitat in these clays, and grow most luxuriantly. The *Sarcobatus* reaches its highest growth in this region. The somber appearance given to the country by the black clays is unfavorable to it. At the Great Bend

there is a large thickness of the strata filled with concretions that are made up mostly of an aggregate of fossils, as *Ammonites, Baculites*, etc. Near Chain de Roche creek these concretions have been swept down into the Missouri by the swift current, during the spring floods, and in the low water of autumn they present a picturesque appearance.

Although the rivers cut deep channels through the different formations, we do not meet with the Fox Hills Group along the Missouri, until we reach nearly up to the mouth of Cannon Ball river, yet fifty miles or more before reaching that point it has overlapped the Fort Pierre Group. In traveling across the plain country westward from Fort Pierre, we find it occupying the entire area. Very soon after passing west of the Big Cheyenne river the traveler will readily recognize its presence by the more cheerful appearance that it gives to the surface, as well as by the greatly increased growth of vegetation. The water is pure and good, and springs become quite common in the hills.

An important feature in the geology of the West is the great lake basins, which seem to set in the older formations and in each other like dishes. The principal one is the Fort Union, or Great Lignitic Group, which forms the transition group, from the strictly marine condition of the Cretaceous period, to the epoch of the numerous fresh-water lakes, which were scattered all over the country west of the Mississippi. This group was called the Fort Union or Lignitic Group in 1861,* and supposed to be of Eocene age.

It was described as consisting of beds of clay and sand, with round ferruginous concretions, and numerous beds, seams and local deposits of lignite, great numbers of dicotyledonous leaves, stems, etc., of the genera *Platanus, Acer, Ulmus, Populus*, etc., with very large leaves of true fan palms; also *Helix, Melania, Vivipara, Corbicula, Unio, Ostrea, Corbula* and scales of *Lepidotus*, with bones of *Trionyx, Emys, Compsemys, Crocodilus*, etc; as occupying the whole country around Fort Union, extending north into the British possessions to unknown distances, southward to Fort Clark, under the White River Group on North Platte river above Fort Laramie, and on the west side of Wind River mountains; and as having a thickness of 2,000 feet or more. The passage from the brackish to the fresh water beds seems not to be marked by any material alteration, in the nature of the sediments; nor have we any reason for believing, that any climatic or other important physical changes beyond the slow rising of the land, and the conse-

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* Proc. Acad. Nat. Sci.

quent recession of the salt and brackish water, took place during the deposition of this group.

Prof. Hayden proposed to call the strata found in the Judith basin near the sources of the Missouri river, consisting of ancient lake deposits, and not differing materially from those of the Fort Union Group, the Judith Group. It contains impure beds of lignite, fresh-water mollusca, a few leaves of deciduous trees and a great number and variety of reptilian remains.

There is no real physical break in the deposition of the sediments between the well-marked Cretaceous and Tertiary strata. In some localities the continuity is clear and beautiful in the highest degree. On Green river, and in the Bitter Creek Valley, one can trace the continuity step by step, so far as the strata are concerned, from the Cretaceous through the greatest thickness of clays, sands, and sandstones of the Lower Tertiary to the purely fresh water beds of Green river shales, Washakie, or Bridger Groups. In these localities the influence of the elevation of the mountain ranges has been such as to expose the outcroping edges of all the strata, from the Cretaceous to the sands of the most recent Tertiary, like the leaves of a book. In the clays interspersed among the coal beds, in the Bitter Creek valley, several species of oyster shells occur in seams. At Bear river, we have well defined Cretaceous strata and from these we ascend, through a series of sandstones and clays, with an abundance of shells of the genus *Ostrea* and a few other marine forms, resembling Tertiary types as much as Cretaceous. Soon we come to the coal-beds, which at this locality are nearly vertical. Above them we find seams of oyster shells, but no other marine forms. And finally, high up in the upper beds of the coal group, we find the greatest profusion of brackish and fresh water life. The coal group in Weber Valley, and at Coalville, is referred to the Cretaceous.

Prof. F. B. Meek* said that some of the specimens from near Bear river, and at Coalville, Utah, from a light-colored sandstone containing beds of a good quality of brown coal, appear to belong to a member of the Cretaceous series not corresponding to any of those named in the Upper Missouri country; though it is, as he believed, represented by a similar sandstone under the oldest estuary Tertiary beds at the mouth of the Judith river, on the Upper Missouri. In 1860, Colonel Simpson brought from this rock, on Sulphur Creek, a small tributary of Bear river, in Utah, some casts of *In-*

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* Hayden's U. S. Geo. Sur. of Wyoming, etc.

oceramus, and other fossils, and in some remarks on this collection* he referred this formation to the Cretaceous. The collections that have since been brought in from it, in Utah, by Mr. King's and Dr. Hayden's surveys, confirm the conclusion that it belongs to the Cretaceous, as they contain, among other things, species of *Inoceramus*, *Anchura* and *Gyrodes*—genera that seem not to have survived the close of the Cretaceous period. In addition to this, there is among Dr. Hayden's collections from this rock, at Coalville, a *Turritella* that he could not distinguish from *T. martinezensis*, and a *Modiola* which appeared to be specifically identical with *M. pedernalis*. Dr. Hayden also had, from a little above the coal beds at Coalville, specimens of oyster that seemed much like *O. idriaensis* and *O. breweri*, of Gabb, from the upper beds of the California Cretaceous. From the affinities of some of these fossils to forms found in the latest of the beds referred in California to the Cretaceous, and the intimate relations of these marine coal bearing strata of Utah to the oldest Tertiary of the same region, and the apparent occurrence of equivalent beds bearing the same relations to the oldest brackish-water Tertiary beds at the mouth of Judith river on the Upper Missouri, he was inclined to believe that these Coalville beds occupy a higher horizon in the Cretaceous than even the Fox Hills beds of the Upper Missouri Cretaceous series; or, in other words, that they belong to the closing or latest member of the Cretaceous.

All of the explorers of this region concur, in the statement, that the above mentioned Cretaceous beds are intimately related to the succeeding brackish water deposits that appear to belong to the oldest Tertiary; the two formations, wherever they occur together, being conformable and without any intermediate beds, so that the one seems to shade into the other, without any abrupt or sharply-defined line of separation; the change being mainly indicated by a gradual transition from beds containing Cretaceous types of only marine origin, to those with brackish and fresh water types, apparently most nearly allied to early Eocene species of the old world.

So far as yet known, there would appear to be no strictly marine Tertiary deposits in all this interior region of the continent; even the lower parts of the surface here having been apparently gradually elevated above the sea level, at, or very near, the close of the Cretaceous period. For the same reason all of the beds hitherto referred with confidence to the Cretaceous are of undoubted marine origin, as they contain only marine types.

* Proc. Acad. Nat. Sci.

These Cretaceous gulfs or seas, however, evidently did not occupy the whole country here, as we know from the absence of Cretaceous deposits throughout what were doubtless wide areas, or possibly, in some cases, smaller islands of dry land at that time. As the whole surface was gradually elevated, however, even the lowest portions rose finally to near the tide level, thus probably leaving large inlets and estuaries of brackish waters, that subsequently became so far isolated, by the continued elevation, and from sedimentary deposits, as to prevent the influx of the tides and form fresh-water lakes, in which the later fresh-water and terrestrial types of fossils only were deposited.

That this change from marine to brackish-water conditions was exactly contemporaneous with the close of the Cretaceous epoch, and the introduction of the Tertiary in Europe, is not certain; nor is it necessary that this should have been the case to constitute the older rock Cretaceous, and the later Tertiary, because in the use of these terms we have reference rather to the order of succession of certain great physical changes, affecting life in distantly separated parts of the earth, than to the exact time of the occurrence of these changes.

He described from Bear river, near Sulphur creek (now Laramie Group), *Goniobasis chrysalis.*

From the Dakota Group, twelve miles southwest of Salina, Kansas, *Crassatellina oblonga*, *Arca parallela*, *Yoldia microdonta*, *Corbicula nucalis*, *C. subtrigonalis*, *Cardium salinaense*, *C. kansasense*, *Arcopagella mactroides*, *Tellina subscitula*, *Leptosolen conradi*, *Turritella kansasensis*, and *Turbo mudgeanus.* From opposite Sioux City, in Dakota county, Nebraska, *Unio nebrascensis.*

From the Fort Pierre Group, near Medicine Bow Station, Union Pacific Railroad, *Inoceramus altus.* From the Fox Hills Group, at the mouth of Deer creek, on North Platte, in Wyoming, *Tapes wyomingensis.* From Box Elder and Colorado City, Colorado, *Anisomyon centrale.*

From the Fort Benton Group, at Oil Springs, twenty miles west of Fort Bridger, Wyoming, *Cardium pauperculum;* from Point of Rocks,* Wyoming, *Anomia gryphhorhynchus.*

From Salt Lake, Utah, *Pachymya truncata*; and from Canon City, *Mactra canonensis.*

Wm. M. Gabb† described, from Chihuahua, Mexico, *Lima kimballi.*

Alfred R. C. Selwyn‡ described the Jackass mountain Conglomerate

* Hayden's 5th Rep. U. S. Geo. Sur. Terr.
† Proc. Acad. Nat. Sci.
‡ Geo Sur. Canada.

Group of British Columbia. It consists of hard, close-grained and thick-bedded, greenish sandstones or quartzites, green and black shales, and above these, massive thick-bedded pebble conglomerates, dipping generally at low angles in various directions; some of the inclosed pebbles are of rocks belonging to the Cache creek series. At Jackass mountain the road is built round, or excavated out of vertical cliffs of these conglomerates, at from 800 to 900 feet above the river, into which you can almost drop a stone from the parapet of the road; and at a short distance back they rise into hills, not less than 3,000 feet above the valley, which they occupy to within about five miles from Lytton. This group belongs to the Upper Cretaceous, and is above what he called the Upper Cache Creek Group.

The road to Cariboo, between Clinton and Lillooet, runs through a valley transverse to the strike of the rocks, from one to two miles wide, on either side of which hills rise abruptly from 1,000 to 2,000 feet. The Upper Cache Group was first observed here by Mr. James Richardson, the base of which he supposed to be about two miles west of Clinton. The beds have generally a high westerly dip. They consist of a great volume of bluish, dove-colored, and white limestones, often a good marble, interstratified with brown dolomitic limestone, red and green shale, and epidotic and chloritic rocks, with others which closely resemble rocks of the Quebec Group, in the eastern townships of Canada. These rocks occupy the country westward for about six miles. On their strike to the northward, they can be easily traced by the eye, from the almost snowy appearance of the limestones for 20 or 30 miles; and in the opposite direction they can be traced, by the same characters, for 10 to 12 miles, to another transverse narrow valley called Marble canon. A narrow, deep lake, of clear water, occupies the bottom of this canon, the white cliffs of limestone rising on either side of the lake to heights of from 2,000 to 3,000 feet above the water. About half-way up, on the north side, the limestone beds stand up in masses, which look like detached columns of a diameter of from 50 to 100 feet, and from 300 to 400 feet high, due to the unequal weathering of the almost vertical strata. The limestones are succeeded by a considerable thickness of black shales, sometimes soft and calcareous, but often hard and flinty.

Mr. James Richardson* described numerous sections, in the Cretaceous rocks of Vancouver and adjacent islands, showing the coal seams; one of which occurs about five miles from the shore on the southwest

* Geo. Sur. Can.

side of Comox harbor, on a small tributary of the Puntledge river. A descending section is as follows:

1. Brownish or drab-colored, slightly calcareous sandstone, the grains of which are composed of quartz, feldspar and mica, with some of a black substance supposed to be peroxide of manganese, the beds being from one to five feet thick, 45 feet.

2. Coal, black and shining, clean and free from shale, 4 feet 6 inches.

3. Brownish-black argillaceous shale, and greenish-brown sandstone, interstratified with one another in thinish layers, the shale predominating, and both holding thin irregularly-distributed, lenticular patches of coal, which may constitute about one tenth of the mass, no indications of roots penetrating the upper part of the bed were observed, 15 feet.

4. Coal, apparently of good quality, 5 feet 4 inches.

5. Brownish-gray or light drab sandstone, in beds of from one foot to eighteen inches, 10 feet.

6. Coal, apparently clean and of good quality, 6 feet.

7. Brownish-gray or light drab sandstone interstratified with thin layers of black, soft, argillaceous shale, 3 feet.

8. Coal, without observed impurities, 10 feet.

Total, 98 feet 10 inches.

A section near Departure bay shows a thickness of 1,538 feet.

Prof. E. D. Cope* described the Cretaceous along the line of the Kansas Pacific Railroad, where it consists of the Dakota, Benton and Niobrara Groups. The Dakota Group constitutes the bluffs at Salina, one hundred and eighty-five miles west of the State line of Missouri, and continues as far as Fort Harker, thirty-three miles farther west. They are a coarse, brown sandstone, containing irregular concretions of oxide of iron and numerous mollusks of marine origin. The Benton Group appears at this point, containing large quantities of dicotyledonous leaves and other forms of land vegetation. It appears also at Brookville, eighteen miles east, and at Bunker Hill, thirty-four miles west of this Fort. The Niobrara Group forms the bluffs at Fort Hays, seventy miles west of Fort Harker, and from this place to Fort Wallace, one hundred and thirty-four miles beyond. This group consists of two parts—a lower, of dark bluish calcareo-argillaceous character, often thin-bedded; and an upper, of yellow and whitish chalk, much more heavily bedded. Near Fort Hays the best section may be seen at a point eighteen miles north on the Saline river. Here the

* Hayden's 5th Rep. U. S. Geo. Sur. Terr.

bluffs rise to a height of 200 feet, the yellow strata constituting the upper half. Half way between this point and the fort, *Haploscapha grandis*, and *H. eccentrica* occur. Some of them are twenty-seven inches in diameter. Fragments of *Anogmius* occur in the yellow bed and *Inoceramus problematicus* in the blue.

Along the Smoky Hill river, 30 miles east of Fort Wallace, the strata have a gentle dip to the northwest. The yellow and the blue strata are about equally fossiliferous and pass into each other by gradations and by slight laminar alternations at their line of junction. *Cimolichthys semianceps*, *Liodon glandiferus*, and *L. dyspelor* occur in both classes of strata. The yellow strata are remarkably uniform in mineral contents, but the blue contain numerous concretions and great abundance of thin layers of gypsum and crystals of the same. Near Sheridan, concretions and septaria are abundant. In some places the latter are of great size, and being imbedded in the strata have suffered denudation of their contents, and the septa standing out form a huge honeycomb. This region, and the neighborhood of Eagle Tail, Colorado, are noted for the beauty of their gypsum crystals. These are hexagonal-radiate, each division being a pinnate or feather-shaped lamina of twin rows of crystals. The clearness of the mineral and the regular leaf and feather forms of the crystals give them much beauty. The yellow bed disappears to the southwest, west, and northwest of Fort Wallace, beneath a sandy conglomerate of Tertiary age.

He described, from the Fort Benton Group, at Bunker Hill station, Kansas, *Apsopelix sauriformis.*

He described, from the Niobrara Group, near Eagle Tail in Colorado, *Liodon crassartus*, now *Platecarpus crassartus;* from Kansas,* *Ornithochirus harpyia, O. umbrosus;* from near Butte creek, *Cynocercus incisus;* from Sheridan, *Plesiosaurus gulo.*†

He determined‡ the Upper Cretaceous age of the Lignitic strata of the Bitter Creek Basin of Wyoming, and described, from near Black Buttes station, on the U. P. R. R., 52 miles east of Green river, and near the Hallville coal mines, *Agathaumas sylvestris.* This dinosaurian was discovered between the thinner or lower strata of the Bitter creek series of coal, which at this point occupy a position of elevation and crop out high on the bluffs. Two strata appear above the sandstone in which the bones occur, and one below it.

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* Proc. Am. Phil. Soc.
† Proc. Acad. Nat. Sci.
‡ Pal. Bull. No. 4 and No. 10, and Proc. Am. Phil. Soc.

Prof. O. C. Marsh* described, from Smoky Hill river, in Western Kansas, *Pterodactylus occidentalis*, *P. velox*, *P. ingens*, *Graculavus anceps*, *Hesperornis regalis*, *Lestosaurus simus*, now *Platecarpus simus*, *L. felix*, now *P. felix*, *L. latifrons*, now *P. latifrons*, *L. gracilis*, now *P. gracilis*, *Rhinosaurus micromus*, now *Liodon micromus*, *Edestosaurus rex*, now *Clidastes rex*, *Ichthyornis dispar*, *Colonosaurus mudgei*, now *Ichthyornis dispar;* and from the greensand at Hornerstown, New Jersey, *Graculavus velox*, *Graculavus pumilus*, and *Palæotringa vagans.*

Dr. Joseph Leidy† described, from Texas, *Otodus divaricatus;* from Kansas, *Oxyrhina extenta;* from New Jersey, *Acrodus humilis;* and from Mississippi, *Pycnodus faba.*

F. B. Meek and J. H. Kloos‡ found the Benton Group underlying the drift gravel and clay in the Sauk valley, in Minnesota.

T. A Conrad§ described, from the Yellow Chalk, near the Saline river, Kansas, *Haploscapha grandis*, and *H. excentrica.*

And Prof. Leo. Lesquereux described, from the hard ferruginous sandstone of the Dakota Group, in Kansas, *Pterospermites quadratus*, now *Pterophyllum quadratum*, *Pterospermites multinervis*, now *Pterophyllum multinerve*, *Pterospermites haydeni*, now *Pterophyllum haydeni*, *Magnolia ensifolia*, now *Celastrophyllum ensifolium*, *Quercus mudgei*, now *Protophyllum mudgei*, *Aralia quinquepartita*, *Platanus heeri*, and *Sassafras obtusus*, now *Cissites obtusus.* From the reddish, ferruginous, hard shale of the Laramie Group, below the Coal at Evanston, Utah, *Quercus negundoides*, *Betula stevensoni*, *Rhus evansi*, *Juglans rhamnoides;* from a grayish, fine-grained, hard shale on the divide between the source of Snake river and the southern shore of Yellowstone lake, *Gymnogramma haydeni*; and from six miles above Spring canon, and top of hills between Fort Ellis and Botteler's ranch, Colorado, *Myrica ambigua*, *Quercus ellisana*, and *Q. pealei.*

In 1873, Prof. Leo Lesquereux‖ described the Lignitic Group, from the Raton mountains, northward to Denver and Cheyenne, and then along the Union Pacific railroad to Evanston. In passing obliquely from the town of Trinidad to the Raton valley, in a northwest direction, the stage-road gently ascends about 150 feet to a plateau which, at the surface, consists of the black shale of the Fort Pierre Group, and

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* Am. Jour. Sci. and Arts, 3d ser., vol. 3 and 4.
† Proc. Acad. Nat. Sci.
‡ Am. Jour. Sci. and Arts, 3d ser., vol. 3.
§ 5th Rep. Hayden's U. S. Geo. Sur. Terr.
‖ Hayden's 6th Rep. U. S. Geo. Sur. Terr.

contains well preserved, large, characteristic shells in ferruginous concretions. But soon the plain appears cut by undulations which already, one mile from Trinidad, have their tops strewn with large broken flags of sandstone, over which no other trace of fossil remains, but marine plants or fucoids are seen. A little farther from the town, the same sandstone is in place, immediately and conformably overlying the black shale; and in entering the small valley of the Raton, the road curves around steep hills, whose base rests upon the fucoidal sandstone, and whose sides, exposed by denudation, are blackened by outcrops of coal at different altitudes. A section, along a small branch, in whose banks the lignite-beds appear in succession down to Raton creek, and then down this creek to Purgatory river, where the Fort Pierre Group is exposed, shows the lignitic 300½ feet, succeeded by 178 feet of sandstone. The characters of the sandstone are as follows:

First.—Its general color is whitish-gray, so white indeed, sometimes, that the lower strata, seen from a distance, appear like banks of limestone.

Second.—Though generally hard, it weathers by exfoliation under atmospheric influences, and its banks are thus molded in round undulations; and as it is locally hardened by ferruginous infiltrations, it is often too concretionary or grooved in cavities, so diversified in size and forms, that sometimes the face of the cliffs shows like the details of a complicated architecture.

Third.—It is entirely barren of remains of animals.

Fourth.—From its lowest stratum to its upper part, it abounds in well-preserved remains of marine plants or fucoids, which, at some localities, are seen even in the sandstone over lignite-beds.

Fifth.—In its upper part, the sandstone or the shales of this group are mixed with broken *debris* of land-vegetation, with which also fucoidal remains are found more and more abundant in descending.

In passing from the black shale of the Fort Pierre Group to this group of sandstone beds overlaying it, the difference in the characters is striking, not only in considering their compounds, but in the class of fossil remains which they contain, the traces of deep marine animal-life predominating in the black shale, while here they have totally disappeared. In the sandstone, marine life still marks its activity only by the abundant remains of fucoids, indicating, by their growth, a comparatively shallow water. They point out, therefore, a slow upheaval of the bottom of the sea in which they appear to have lived; for their stems penetrate the sandstone in every direction. And this indication is still more manifest in the great abundance of *debris* of land-plants,

which seem as if ground by the waves, thrown upon the shore and mixed in the sand with fucoidal remains. That this sandstone forms all over and around the Raton mountains, the base of what is called the Lignitic Group, and that it overlies the black shale of the Fort Pierre Group, has been remarked by all the geologists who have explored the country. Dr. Leconte, considering the strata as Cretaceous, mentions them in his report as continuing southward of the Raton, along the base of the Rocky mountains, forming an immense terrace, which extends as far south as the valley of the Tonejo, and perhaps even to the north bank of the Cimarron. From this place northward to the base of the Spanish Peak, these sandstone beds, always with the same characters and superimposed upon the Fort Pierre Group, form an immense terrace, perpendicularly cut, like a wall facing east, high above the plain. They support the lignitic beds which still tower above them, either ascending in steep declivities from the top of the perpendicular sandstone, or receding at some distance, where they have been more deeply sapped by erosion. This abrupt front, says Dr. Hayden, seems to form a sort of shore-line of a wonderful basin, as if a body of water had swept along and washed against the high bluffs, as along some large river. The stage-road from Trinidad to Pueblo follows the base of these cliffs for thirty-two miles. South of Trinidad, the lignitic measures have been followed nearly without interruption to the Maxwell estate, about fifty miles. The area which they cover, at and around the Raton mountains, may be estimated at 600 to 800 square miles. The same formation is reported farther south, near and around Santa Fe; in the Gallisteo valley; along the mountains to Albuquerque, and in the valley of the Rio Grande, as far south as Fort Craig. Everywhere, with a single exception, these Lignitic measures have exposed, by their relative position, by the absence of animal remains in the thick beds of sandstone, which indicate their base and constitute their foundation, by the homology of their marine and land flora, as recognized in the remains of fossil-plants which they contain in abundance, all the characters authorizing the separation of this group from the Cretaceous formation.

From Pueblo to Canon City, forty-five miles, the stage-road follows a broad valley, closed on the south side by the Greenhorn mountains, on the north side by the Rim Range of the Colorado mountains, over which towers Pike's Peak, whose summit is visible all the time. The whole valley is essentially Cretaceous; all the eminences, either near the borders or in the middle, are hills of this formation, molded by the erosions of the Arkansas river, which has dug numerous beds in this

soft material. The borders of its present bed, like those of its old ones, where the road sometimes meanders, as in a labyrinth, are picturesquely marked by rocks of diversified forms, resembling monuments built by the hand of man, towers, columns, ruins, etc., often strewn around in confusion. On the south side of the river, however, about fifteen miles before reaching Canon City, the aspect of the country is modified by the appearance of a group of hills of the Lignitic, filling the space from the base of the Greenhorn mountains to the borders of the river, three to four miles in width. The whole area covered here by the Lignitic is about 33 square miles. The lower strata, overlying the sandstone, rise abruptly about 50 feet above the Arkansas river, forming a kind of narrow plateau, over which the hills of the upper Lignitic rise up to about 500 feet. The whole thickness of the lignite-bearing strata is estimated at about 600 feet. The lower sandrock, about 200 feet thick, is the equivalent of the lower fucoidal sandstone of the Lignitic of the Raton mountains, and it graduates into the Lignitic above. Indeed, in some places the lower sandstone includes in its divisions beds of lignite to its base.

From Pueblo northward no trace of the Lignitic is seen along the mountains till near the southern base of a range of hills, the Colorado pinery, which, in its eastern course, at right angles from the primitive mountains, forms the divide of the waters between the Arkansas and the Platte rivers.

The succession of the Cretaceous strata is clearly marked on the banks of Monument creek. In following it up from Colorado Springs, the formation can be studied to the top of the black shale of the Fort Pierre Group, and above this to a bed of brownish sandstone, separated from the black shale by thin layers of *Tuten clay* and soapstone, where the last remains of Cretaceous animals, especially fragments of *Baculites*, are still abundant. Over this is the sandstone, barren of any kind of remains, overlaid in the banks of the creek, by a bed of fire-clay, or very soft chocolate-colored shale, which marks the base of the following section at low-water level of the creek:

1. Brown, laminated fire-clay, or chocolate-colored soft shale, a compound of remains of rootlets, and leaves and branches of undeterminable conifers, 2 feet.

2. Coal, soft, disaggregating under atmospheric influence, 2 feet.

3. Chocolate-colored clay shale, like No. 1, with a still greater proportion of vegetable *debris*, 6 feet.

4. Soft, yellowish, coarse sandstone in bank, 8 feet.

5. Clay, shale and shaly sandstone covered slope, 130 feet.

6. Soft, laminated clay, interlaid by bands of limonite iron, thin lignite seams, and fossil-wood, 88 feet.

7. Lignitic black clay, in banks, 32 feet.

8. Fine-grained conglomerate, 112 feet.

9. Fine-grained sandstone, 4 feet.

10. Coarse conglomerate, 7 feet.

11. Sandstone, 3 feet.

12. Ferruginous hard conglomorate, 32 feet.

Total, 426 feet.

The soft chocolate-colored, laminated clay, Nos. 1 and 3 of this section, has the same composition, color, and characters as the clay under and above the coal-beds of the Raton mountains and of the Arkansas valley. It is the same, more or less darkly colored by bitumen, which prevails over the whole area of the Lignitic. This clay takes the place of the fire-clay so generally underlying the coal-beds of the carboniferous measures, where, as in the Lignitic, it forms, beside the floor, some bands, clay partings, separating coal strata, and soft shale overlying them. The dicotyledonous leaves, specifically identical with those found at Raton mountain and in the Arkansas valley, leave no doubt about the cotemporaneity of these Lignitic measures.

By far the most interesting member of this section is the conglomerate at the top. This is a compound of small grains or pebbles, mostly of white quartz, and of silex of various colors, varying in size, at least for the largest proportion, from that of a pea to that of the head of a pin. Pebbles as large as a walnut are abundant. This formation, 150 feet thick, at least, is conformable to the strata overlying the coal of the base of the section, and here, as it will be seen at other places, it overlies immediately thick banks of soft, laminated, bituminous, black clay. The materials forming this conglomerate are cemented together by a thin coating of carbonate of lime, which easily disaggregates under atmospheric influence, except in the upper stratum, where the cement has been hardened by ferruginous infiltration. Its greater resistance has then locally preserved the whole mass from destruction. These conglomerate cliffs, which, from the hotel of Colorado springs, arrest the view to the west, appearing like high bluffs of white sandstone, are evidently the mere vestiges of an extensive formation, originally covering the base of the mountains from the Arkansas river, extending far inland to the east. For hundreds of miles the ground of Colorado is formed by its *debris*. They have given to the soil, that apparent sterility of surface, which is so remarkably changed into fertility, by the culture

of the substratum composed of softer-grained materials and lime. Nearer to and along the base of the Colorado pinery, whose lignitic hills have escaped destruction, by the upheaval of the ridge, these conglomerates, still detached from the common mass, and molded into the most diversified forms by disintegration, have scattered columns, pinnacles, round towers, and cupolas over a wide area, the far-famed Monument Park.

From the mouth of Bear creek into the Platte, a few miles west of Denver, the Lignitic formation abutting against the Cretaceous and diversely thrown up by the upheaval of the primitive mountains, follows the base of these mountains in a nearly continuous belt to Cheyenne. Though generally covered by detritus, the basin is deeply cut by all the creeks descending to the plain—Clear, Ralston, Coal, Erie, Boulder, Thompson creek and others, and the strata thus exposed. Golden is on the banks of Clear creek, at its outlet from a deep canon, and in the middle of a narrow valley, shut up, on the west, by the slopes of the primitive rocks, and on the east by a high wall, a trap-dike, which here follows the same trend as that of the mountain at a distance of one to one and one-half miles. As it is generally the case along the eastern base of the Rocky mountains, the more recent formations have been thrown up and forward, and their edges upraised to a certain degree nearest to the uplift, and thus succeeding each other by hog-backs facing the mountains, they pass toward the plains in diminished degrees of dip and soon take their horizontal position.

At Golden, the lignitic strata, compressed, as they are, between two walls of eruptive rocks, have been forced up on the western side, in a nearly perpendicular position, while on the other they were thrown up, at the same time, by the basaltic dike, and thus folded or doubled against their faces, in the same way, as the measures of the anthracite basin of Pennsylvania have been so often compressed in multiple folds between the chains of the Allegheny mountains. In that way the lowest strata of the Lignitic, which are nearly perpendicular, overlie the upper Cretaceous strata, which, following the slope of the mountain's plunge, incline in a less degree. The line of superposition of both formations is seen along a ditch opened for a canal of irrigation, about two hundred feet from the tunnels, made in a bank of clay which underlies the lower lignite bed, and which is worked for pottery. These upper Cretaceous strata are seen in the same position, and exactly of the same nature as at Gehrung's; thin beds of soapstone or laminated clay, with Cretaceous fossils, and above them the same kind of *Tuten-clay*, a few inches thick, under the lower sand-

stone of the Lignitic, which is there covered. The surface of the ridge formed by the upthrow is pierced by the edge of the perpendicular strata, especially of the hard sandstone, and there the characters of the lowest beds are recognized at many places as the same as those of the fucoidal sandstone of the Raton mountains. At the cut made across the measures by Clear creek, the lower sandstone appears proportionally thin, 10 to 20 feet. It is a white, soft-grained sandstone, hardened by metamorphism, containing, beside remains of dicotyledonous leaves, some species of finely preserved fucoids. In following the same sandstone to the south it is seen increasing in thickness, and near and under the Roe coal, five miles from Golden, it forms a high, isolated ridge, at least 200 feet thick, barren of any kind of remains, except some fucoids.

By its compound, the alternance of its coarse-grained and soft-grained strata, these being often mere clay or mud beds, its characters appear the same as those of the lower lignitic sandstone of the Raton mountains. It has, too, broken, undeterminable fragments of wood, Cyperaceæ, etc. Beside the species of fossil dicotyledonous leaves found in the white sandstone of Golden, most of them homologous, or even identical with some species of the Raton and other localities, it has one of those very rare land plants, which has been described and recognized in Europe as pertaining, as yet, exclusively to the Eocene.

The finest and best preserved specimens of fossil leaves that have ever been found in this country, with the exception, perhaps, of those of Black Butte, have been found at and around Golden, in the hard metamorphosed white sandstone, under and interlying the beds of coal, and in the beds of white clay upheaved against the sides of the basaltic dike; a clay, hard as silex from metamorphism, having mostly remains of palm leaves; and from three miles south of Golden, from a sandstone still upheaved, near the tail of the dike, but scarcely changed by heat, and easily cut in large pieces. The continuity of the Lignitic formation is traced north toward Cheyenne, where the conglomerate sandstone covers the face of the country, and all the facts discovered, tend to confirm the statement made by Dr. Hayden in 1868, that all the lignite Tertiary beds of the West are but fragments of one great basin, interrupted here and there by upheaval of mountain chains, or concealed by the deposition of newer formations.

At Medicine Bow, the line of connection with the underlying Cretaceous is, perhaps, more difficult to fix than at other localities, the fucoidal sandstone here being mostly barren of remains of marine plants. But from its base to its top, in a thickness of, perhaps, 200

feet, it is barren, too, of any remains of animals, while here and there branches of fucoids appear, as thrown by the waves, being generally mixed with fragments of wood and stems of dicotyledonous plants. From the cut of the railroad west of Medicine Bow, where this sandstone is seen overlying the Cretaceous, and where two fine mineral springs come out from its base, it is continuous to Carbon, in repeated and deeper undulations, forming basins, which at this place and around contain the upper Lignitic formation, with remarkably thick beds of combustible mineral. The coal is mined at Carbon Station by a shaft descending through the following strata:

1. Shale, clay, and sandstone at top, 35 feet.
2. Ferruginous shale, with dicotyledonous leaves, 3 feet.
3. Clay, shale, and sandstone, with plants at top, 18 feet.
4. Coal (main), 9 feet.
5. Fire-clay and shale, with dicotyledonous plants, 20 feet.
6. Coal, 4 feet.
7. Fire-clay and shale, 8 feet.
8. Coal, 4 feet.

Total, 101 feet.

In following the railroad from Black Butte westward, the Lignitic formation, already seen at the surface of the country from below Bitter Creek Station, forms an irregularly broken ridge, whose general dip toward the east is varied by low undulations. In that way the measures slowly ascend to Point of Rocks, where they overlie the black shale of the Fort Pierre Group, there constituting the axis of an anticlinal, which is cut below Point of Rocks, by the meanders of Bitter creek. The counterface of the axis appears westward, in corresponding strata, after passing Saltwell valley, and hence the dip to the west brings to the surface the upper strata of the Lignitic at Rock Spring. The section of the measures is perfectly clear and exposed in its whole length. At Point of Rocks, and near the highest part of the anticlinal axis, the Cretaceous strata are exposed 80 feet in thickness, immediately and conformably overlaid by 185 feet of the Lignitic sandstone, which, from its base, bears fucoidal remains. It has, moreover, the composition and mode of disintegration of the same formation at Raton, east of the station, 25 feet above the base of this sandstone, there is a bed of coal 8 feet thick. Farther east, at Hallville, a Lignitic bed, overlaid by shales where are imbedded a quantity of fossil shells, is worked near the level of the valley at a short distance from the railroad. At Black Buttes a bed of lignite is worked, too, above the sandstone. At Rock Spring, in boring for an artesian

well, 16 beds of coal making 48 feet in thickness were passed at 728 feet, and at 1,180 feet the sandstone of the Lower Lignitic had not been pierced. He found a remarkable analogy, not to say identity, between the 547 feet of measures above the lignite beds at Evanston and the conglomerate which tops the Lignitic at Colorado Springs and other places.

The masterly review of the Lignitic Group, by Prof. Lesquereux, lead him to the conclusion that it is of Eocene age. He said that the Upper Cretaceous is positively characterized as a deep marine formation. Immediately over it, the sandstone shows, in its remains, the result of the upheaval of a wide surface exposed to shallow marine action, as indicated by fucoidal life. The upheaval continuing, this area is brought out of marine influence to be exposed to that of the atmosphere. It is a new land, cut in basins of various sizes, where fresh water is by and by substituted to brine, where vegetable life of another character appears, where swamps are filling with clay and floating plants, where peat-bogs in their growth form deposits of combustible matter, etc. To suppose that the marine action is totally banished from such a land would demand the absurd admission of an absolutely flat surface. Of course estuaries penetrate into it at many places; their waters feeding marine species, brackish shells; their bayous inhabited by Saurians, and their remains mixed with leaves of the trees growing on the borders and preserved together in a fossil state, without impairing the true character of the formation by what palæontology considers as types of different ages. The surface of the Eocene sandstone, before its separation from marine influence, was, of course, uneven. This sandstone has, therefore, the general characters of the Eocene, while in some troughs, Cretaceous species, still living in deep water, may have left their remains in the sand. Even if these remains were numerous, their presence does not change the age of the formation. But on this subject, and in comparing our Eocene sandstone to the other groups established by geology, we find, in its abrupt and permanent separation from the Cretaceous, its lithological compounds, its total barrenness from animal remains, at least generally, and the homogeneity of its flora, reliable and constant characters better defined than in any geological division admitted by science. This sandstone formation is inexplicable. It can be compared to nothing but the millstone-grit of the Carboniferous epoch. How to explain why, at once, animal life seems to disappear from the bottom of the sea, to be superseded by marine vegetation? May this change have been caused, perhaps, by a rapid increase of temperature

of the water brought up by the force acting to the upraising of the bottom into land, and afterward into chains of mountains. Though it may be, this change is evident and proves the geological discrimination of the Eocene sandstone from the Cretaceous, a separation the more remarkable, that from numerous observations this sandstone is reported constantly conformable to the Upper Cretaceous beds. As Dr. Hayden remarks in his description of the Lignitic Group of Nebraska, when we bear in mind the fact that wherever this formation has been seen in contact with the latest Cretaceous beds, the two have been found to be conformable, however great the upheavals and distortions may be, while at the junction there seems to be a complete mingling of sediments, one is strongly impressed with the probability that no important member of either system is wanting between them.

After contrasting the distribution and character of the plants with those known from the Tertiary of other parts of the world, Prof. Lesquereux thought himself authorized to deduce the conclusion: That the great Lignitic Group must be considered as a whole and well characterized formation, limited at its base by the fucoidal sandstone, at its top by the conglomerate beds; that, independent from the Cretaceous under it, and from the Miocene above it, our Lignitic formations represent the American Eocene.

He described, from South Park, near Costello's ranch, *Ophioglossum alleni*, now *Salvinia alleni*, *Planera longifolia;* from Elko station, Nevada, *Sequoia angustifolia*, *Thuja garmani*, *Abies nevadensis;* from the Raton mountains, *Sphæria lapidea*, *Chondrites subsimplex*, *C. bulbosus*, *Halymenites major*, *H. striatus*, *Delesseria incrassata*, now *Caulerpites incrassatus*, *Delesseria lingulata;* from Gehrung's coal-bed, near Colorado Springs, *Dombeyopsis obtusa;* from Golden City, Colorado, *Sclerotium rubellum*, *Delesseria fulva*, *Pteris anceps*, *Carex berthoudi*, *Sabal goldana*, *Quercus stramineus*, *Ulmus irregularis*, now *Ficus irregularis*, *Ficus auriculata*, *F. spectabilis*, *Cissus lævigatus*, *Dombeyopsis trivialis*, *D. occidentalis*, now *Ficus occidentalis*, *Sapindus caudatus*, *Ceanothus fibrillosus*, now *Zizyphus fibrillosus*, *Rhamnus cleburni*, *R. goldanus*, *R. goldanus*, var. *latior;* from Erie Mines, Boulder Valley, *Caulinites fecundus*, *Cercis eocenica;* from Carbon station, Wyoming, *Populus decipiens*, *Ficus oblanceolata*, *Coccoloba lævigata*, *Asimina eocenica*, *Zizyphus meeki;* from Black Butte station, *Sphaeria myricæ*, *Opegrapha antiqua*, *Caulinites sparganioides*, *Myrica torreyi*, *Ficus planicostata*, *F. planicostata*, var. *latifolia*, *F. clintoni*, *F. corylifolius*, *F. haydeni*, *Vibernum marginatum*, *V. contortum*, *Cissus lobato-crenatus*, *Aleurites eocenica*, *Paliurus zizyphoides*, *Carpolithes*

falcatus; from the Black Butte saurian bed, *Vibernum dichotomum;* from the Black Butte red baked shale, *Quercus wyominganus;* from Evanston, *Calycites hexaphylla*, *Carpolithes arachioides*, now *Leguminosites arachioides;* from Elk creek, near Yellowstone river, *Carpolithes osseus*; from six miles above Spring canon, near Fort Ellis, *Abies setigera* and *Nyssa Lanceolata.*

He described, from the Dakota Group, six miles south of Fort Harker, Kansas, *Hymenophyllum cretaceum*, *Caulinites spinosus*, *Populites fagifolia*, *Ficus sternbergi*, now *Persea sternbergi*, *Sassafras mirabile*, *S. recurvatum*, now *Platanus recurvata*, *S. harkeranum*, now *Cissites harkeranus*, *Laurophyllum reticulatum*, *Pterospermites sternbergi*, now *Protophyllum sternbergi;* from nine miles above Salina in the Saline Valley, Kansas, *Populites salinæ*, now *Menispermites salinensis*, *P. affinis*, now *Cissites affinis*, and *Pterospermites rugosus*, now *Protophyllum rugosum.*

Prof Meek* said that the coal-bearing rocks at Coalville, Utah, are undoubtedly of Cretaceous age, as he had from the first maintained, and he quoted in support of this view his remarks in Dr. Hayden's Report of 1870, page 299. He prepared a section running from the principal coal-bed, near Coalville, in a northwesterly direction, to Echo canon, a distance, by a right line a little obliquely across the strike of the rocks, of about three and a half miles. This section commences 393 feet below the heavy bed of coal, and furnishes a thickness of 3,980 feet below the conglomerate, or including the conglomerate, which is here 700 feet in thickness, 4,680 feet of strata. Several parts of this section contain marine Cretaceous fossils, the highest of which is gray, soft, sandstone, 30 feet in thickness, and 1,431 feet below the conglomerate. It contains many large *Inoceramus*, *Ostrea* and *Cardium.*

The conglomerate not only composes the towering walls of Echo canon at places forming perpendicular, or even overhanging escarpments, 500 to 800 feet in height, but also rises into mountain masses on the west side of Weber river, near the mouth of the canon. It probably attains a thickness in places of 2,000 feet. This he referred to Tertiary age because of its position above the Cretaceous, its nonconformability with the rocks below it, and its remarkably coarse material.

[To be Continued.]

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*6th Rep. Hayden's U. S. Geo. Sur. Terr.

DESCRIPTION OF A NEW WARBLER OF THE GENUS HELMINTHOPHAGA.

By Frank W. Langdon.

Helminthophaga cincinnatiensis, sp. nov.

Plate VI.)

Adult male; spring plumage. Entire upper parts, excepting forehead, clear, bright, olive green, with a tinge of yellowish in certain lights; quills and rectrices dark plumbeous brown, their outer webs fringed with olive green like that of the back. Below, including crissum, bright cadmium yellow, of nearly the same shade throughout. Forehead, bright yellow, this color bounded anteriorly by a very narrow black line from lores, and behind gradually merging into the clear olive green of crown; feathers of vertex with a median concealed area of black. Lores velvety black; auriculars black, tipped with yellowish-green, giving them a mottled appearance. A yellow area beneath the eye separates the black of lores from that of auriculars.

Greater and lesser wing coverts tipped with greenish-yellow, forming two indistinct wing-bars; outer primary edged with whitish. Inner webs of two outer tail feathers narrowly margined with white near the tip.

Bill, in the flesh, black, excepting extreme tip, and base of lower mandible, which are bluish horn-color; culmen slightly decurved, with trace of a notch at tip. *Rictus with fairly developed bristles** extending nearly or quite to nostrils, here differing from any other species of the genus. Eyes, dark brown; tarsi and toes, pale brownish; claws, paler. Dimensions: Length, 4.75; wing, 2.50; tail, 1.85; culmen, .44, from nostril, .34; tarsus, .70.

The discovery of additional specimens may modify the above description somewhat, for, as Dr. Coues suggests to me, the concealed black of vertex would seem to indicate that this specimen had not quite attained its full spring dress.

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*The presence of this character would by some authors be deemed sufficient reason for the institution of a new genus or sub-genus, but this, it seems to me, would be unnecessary and inadvisable

The species is described from a single specimen, taken by the writer at Madisonville, Hamilton County, Ohio, on May 1, 1880. It has been submitted to Dr. Elliott Coues for examination, and by him in company with Messrs. Ridgway and Henshaw, pronounced to be undoubtedly new. Its relations, according to Dr. Coues, are mainly with *Helminthophaga pinus*, although in the concealed black of vertex and auriculars it slightly resembles certain plumages of *Oporornis formosa*. From *H. pinus*, its nearest ally, it differs in its decidedly larger size, the presence of rictal bristles, the concealed black of vertex and the black ariculars; negatively, in the total absence of white wing bars, white tail *blotches*, and ashy blue on wings and tail. With *O. formosa* it seems hardly necessary to compare it; its smaller size, dissimilar proportions, short tarsi, yellow forehead, and white margin to outer tail feathers, sufficiently distinguish it from that species. A suspicion of hybridism between the two genera is, in the present state of our knowledge, inadmissible.

Of its habits nothing is known except that it was shot while searching for insects at the end of a maple limb about fifty feet from the ground.

It is a little remarkable that this should be the third new species of this genus announced from the eastern United States during the past six years;* such, however, is the fact, and in all three instances the discovery has been made in an already thoroughly explored section. Whether this has any significance as indicating a special tendency of the genus to differentiation on account of changes in its environment, or is merely a coincidence, is of course problematical; the question of an extension of range from some heretofore unexplored habitat would also come in here for consideration.

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*The other two are as follows: *Helminthophaga lawrencei*, Herrick.—Proc. Acad. Nat. Sci. of Phila., 1874, page 220, pl. xv. Locality New Jersey; two specimens now known. *Helminthophaga leucobronchialis*, Brewster.—Bulletin Nuttall Ornithological Club, 1876, Vol. I, No. 1, p. 1, pl. 1. Locality, Newtonville, Mass. Four others now known, one from Penn., two from Conn., and one from an unknown locality.

ORNITHOLOGICAL FIELD NOTES, WITH FIVE ADDITIONS TO THE CINCINNATI AVIAN FAUNA.

By Frank W. Langdon.

Since the publication of the writer's "Revised List of Cincinnati Birds,"* several of the species therein given as "of probable occurrence, but not yet identified" in this vicinity, have been taken, two of which—*Tringa bairdii*, and *Sterna hirundo*, have been already recorded by Messrs. Dury and Freeman.† Four others, namely: *Cistothorus stellaris*, *Helminthophaga celata*, *Melospiza lincolni*, and *Tringa fuscicollis*, have also been added to the list of identified species, and a fifth (*Helminthophaga cincinnatiensis*), entirely new to ornithology, has been discovered, a description and figure of which will be found in another part of this number.

The five additions to our avian fauna herein noted, with the two already recorded by Messrs. Dury and Freeman, bring the total number of species actually identified, in this vicinity, up to 263; leaving 20 unidentified species, whose range includes this locality, yet to be heard from.

For information of value contained in the following notes, acknowledgments are especially due to Mr. John W. Shorten, the well known taxidermist of Cincinnati, Ohio; to J. Bonsall Porter, Esq., of Glendale, Ohio; and to Messrs. Edgar R. Quick and A. W. Butler, both of Brookville, Ind; their names accompanying their respective notes.

The species are here numbered to correspond with the "Revised List of Cincinnati Birds," excepting the additions which are not numbered.

8. Mimus polyglottus, Boie.—*Mocking Bird.*—A set of three eggs, taken by Mr. Joel Metcalf, near Glendale, Ohio, on June 20, 1879, is now in my collection, being the fourth instance known of the breeding of the species in this vicinity, during the past four years.

12. Regulus calendula, Lichtenstein.—*Ruby-crowned Kinglet.*—Mr. Quick favors us with the following extract from his note book in

* A Revised List of Cincinnati Birds, By Frank W. Langdon, this Journal, Vol. 1. No. 4, January, 1879, pp. 167-193.

† Observations on Birds, by Charles Dury and L. R. Freeman, this Journal., Vol. 2., No. 2, pp. 100-104.

regard to this species: On October 16, 1879, a Ruby-crowned Wren took up its abode in a bar-room, in Brookville, where it remained until the 25th, flying about amongst the often noisy patrons of the establishment; and though it was caught and handled to thoroughly identify it, this summary proceeding did not cause it to leave, although the door stood open during the entire day. During its stay it subsisted on flies, which it very expertly captured, returning to its perch to eat them, in the manner of the fly-catchers. Toward the latter part of its sojourn, it became so much accustomed to its strange quarters as to sally out from its perch by lamp-light, after insects attracted by the light. It finally took its departure without apparent cause, probably to resume its southward migration.

18. Sitta canadensis, Linnæus.—*Red-bellied Nuthatch.*—Mr. Butler notes the occurrence of this species at Brookville, from May 5 to 15, 1879, and May 1 to 6, 1880.

20. Thryothorus ludovicianus, var. ludovicianus, Bonaparte.—*Great Carolina Wren.*—One of our common residents. A nest taken at Madisonville, April 29, 1880, differs considerably from the ordinary form, being globular in shape, with the opening in the side. It was situated in a depression in the top of a decayed stump, and is composed chiefly of coarse rootlets and leaf stems, with a lining of horse hair, dried grass and fine rootlets. It had received an outer covering of fresh green moss, well calculated to deceive the unwary collector and *other* predatory animals. The six fresh eggs which it contained were of a creamy-pink tint, changing to a glossy white after blowing; the markings were much less confluent than is usual.

—. Cistothorus stellaris, Cabanis.—*Short-billed Marsh Wren.*—Not previously recorded here. Two specimens, male and female, of this rare little wren were taken in a swampy ravine near Brookville, Ind., September 23, 1879, by Mr. A. W. Butler. Two others seen at the same time. Mr. Butler notes that they were "quite noisy," but very shy.

28. Helminthophaga chrysoptera, Cabanis.—*Golden-winged Warbler.*—Since our record of a single specimen in the "Revised List," this rare warbler has been again recorded by Messrs. Dury and Freeman, in their paper before cited. Two additional specimens have been taken—one by Mr. Butler, at Brookville, Ind., April 29, 1879; the other by Mr. W. H. Whetsel, at Madisonvile, Ohio, April 26, 1880. Mr. Butler notes that it had a peculiar song, resembling that of *H. pinus*, but louder.

—. Helminthophaga cincinnatiensis, Langdon.—*Cincinnati Warbler.*—One specimen, a male, taken at Madisonville, O., May 1, 1880. (See pp. 119-120 and plate VI., this vol.)

—. Helminthophaga celata, Baird.—*Orange-crowned Warbler.*—Taken for the first time in this vicinity, on April 29, 1880, at Brookville, Ind., by Mr. E. R. Quick. The specimen was a female in fine plumage, the orange on crown being very well marked.

45. Dendrœca pinus, Baird.—*Pine-creeping Warbler.*—Brookville, Ind., 1880; April 15th and 24th (Butler); April 23d (Quick); three specimens in all.

46. Dendrœca kirtlandi, Baird.—*Kirtland's Warbler.*—Mr. H. E. Chubb, the taxidermist, of Cleveland, Ohio, writes me of the capture near that place by himself, of two specimens, male and female, of this very rare species, on May 4th and 12th, 1880, respectively. If I remember rightly but six specimens, including the present two, are known, four of which have been taken in Ohio.

48. Dendrœca discolor, Baird.—*Prairie Warbler.*—An additional specimen taken at Madisonville, April 26, 1880, by Mr. W. H. Whetsel.

53. Oporornis formosa, Baird.—*Kentucky Warbler.*—Nest containing four eggs of this species and one Cowbird's egg, taken at Madisonville, May 28th, 1879, by Charles Tompkins, Esq.*

57. (Myiodioctes) Wilsonia mitrata (Gm.), Coues.—*Hooded Warbler.*—Mr. Quick notes two additional specimens of this beautiful and rather rare warbler, taken at Brookville, in May, 1879; and I have verified my query of "August?" in the Revised List, by taking a male, in nearly perfect plumage, at Madisonville, August 4, 1879. It has also been recorded August 30, 1879, by Messrs. Dury and Freeman (*op cit.*)

64. (Hirundo) Tachycineta bicolor, Vieillot.—*White-bellied Swallow.*—Taken by Mr. Porter at Glendale, Ohio, as early as March 22, 1879, the earliest occurrence on record by about a month.

75*a*. (Collurio) Lanius ludovicianus excubitoroides, Coues.—*White-rumped Shrike.*—On March 12, 1879, I took a second specimen of this form near Madisonville, and Mr. J. B. Porter has taken a third on April 23, 1879, at Glendale.

The Madisonville specimen when first seen, was in the top of a low sapling in a pasture, uttering its curious note, which resembled the "rattle" of a Kingfisher much subdued, as if heard in the distance. It was quite shy and soon took refuge in the top of a thorn tree, from which it was shot. Its stomach was filled with the elytra and other remains of beetles.

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* For description of this nest and eggs, see Bulletin Nuttall Orn. Club, Vol. 4, No. 4, Oct , 1879, pp. 236-237,

76. PYRANGA RUBRA, Vieillot.—*Scarlet Tanager.*—Nest containing one egg of this species and one Cowbird's egg, taken at Brookville, Ind., on May 17th, 1880, by Mr. Quick; it was situated in a horizontal fork of a wild crab tree growing on sparsely wooded pasture land, and is described by Mr. Quick as follows: Eight feet from ground; foundation, wool and dry weed stalks; lining entirely of fruit stems of the wild cherry. Dimensions: outside, 4x7x2½ inches; inside, 2½x2½x1 inches. The eggs were far advanced in incubation.

80. CHRYSOMITRIS PINUS, Bonaparte.—*Pine Linnet.*—Mr. Butler found this species quite common at Brookville, Ind., from March 10 to 25, 1879, in the pine trees about his yard; he took about fifteen specimens in all.

84. PLECTROPHANES NIVALIS, Meyer.—*Snow Bunting.*—This bird, which had not been observed here for several years, was found quite plentiful at Jones Station, Ohio (about 30 miles from Cincinnati), by Mr. Walter Douglass, on January 12, 1879; several specimens were taken.

86. PYRGITA DOMESTICA, Cuvier.—*European House Sparrow.*—The "Sparrow question" has assumed such proportions in this country of late years that a paper on the Ornithology of any sparrow-inhabited locality would hardly be complete without some reference to the changes constantly occurring by reason of the presence of that much to be regretted addition to our fauna. To the already immense literature of the subject, I desire to add a note of the entire disappearance of a large colony (several hundred, probably), of Rough-winged and Cliff Swallows, that, until the past two seasons, had their summer quarters and nested about the piers and under the floors of the Brighton bridge over Mill Creek. These have been entirely replaced by the Sparrows. The disappearance of Bluebirds from long occupied positions near houses, and the comparative scarcity of Martins, both due to preoccupation of their building sites by the Sparrows, are matters of common observation; and Mr. Dury dates the rarity of the House Wren at Avondale, from the time of the Sparrow's arrival.

96. SPIZELLA PUSILLA, Bonaparte.—*Field Sparrow.*—I have to note the capture of this species at Madisonville, December 15, 1879, its first known occurrence in winter.

—. MELOSPIZA LINCOLNI, Baird.—*Lincoln's Finch.*—Not previously identified here. Two specimens taken at Brookville, Ind., May 10, 1879, by Mr. Shorten and myself. The birds were found in a deep wooded ravine traversed by a small stream, one of them hopping about on a mass of drift in search of small aquatic insects and larvæ, with which its stomach was found to be filled.

Mr. Quick reports a third specimen, taken near the same locality, in a clover field, May 11, 1880.

108. DOLICHONYX ORYZIVORUS, Swainson.—*Bobolink.*—Specimens taken at Glendale, in September, 1879, its first capture here in the fall.

111. STURNELLA MAGNA, Swainson.—*Meadow Lark.*—A set of eggs taken by Mr. Quick, July 15, 1879, from a nest in which a brood had been reared but a "few weeks before." The nest had been relined previous to the second laying.

114. SCOLECOPHAGUS FERRUGINEUS, Swainson.—*Rusty Grakle*—A pair noted, one of which was shot, at Madisonville, *December* 30, 1879.

115. QUISCALUS PURPUREUS ÆNEUS, Ridgway.—*Bronzed Grakle.*—Mr. Butler writes me that a specimen of this species remained about Brookville, Ind., during part of December, January, and part of February, 1878-9, keeping company with the English Sparrows about the yard and corncrib.

116. CORVUS CORAX CARNIVORUS, Bartram.—*American Raven.*—Mr. Shorten favors us with a note of the capture of a specimen of this species on September 12, 1879, near Marysville, Union County, Ohio, the specimen being now in the collection of Dr. Buffington, of that place. Although too far away to be considered an addition to the birds of this vicinity, its occurrence anywhere in Ohio at the present time is so rare as to merit notice.

141. COLAPTES AURATUS, Swainson.—*Flicker, Golden-winged Woodpecker.*—This species, in addition to being "a very common resident," as given in the "Revised List," is also doubtless a migrant, to some extent at least, as is indicated by the arrival of a pair in the court of the Cincinnati Hospital on April 4, 1880. After disporting and refreshing themselves amongst the shade trees and in the grass, and alighting and climbing, in true woodpecker fashion, along the perpendicular *angle of a brick wall*, they finally left after a sojourn of about two hours.

To one familiar with the situation of the Hospital, in the midst of the densely peopled portion of the city, the occurrence of so arboreal a species there at that time, is strong presumptive evidence of a previous migratory journey.

Other common migratory species were observed at the same place, during April and May, 1880, as follows:

Hermit Thrush, Robin, Bluebird, Field Sparrow (*S. pusilla*), Chipping Sparrow (breeding May 10), and Swamp Blackbird, the latter

being probably attracted by a clump of willows and the small artificial lake in the court.

143. STRIX FLAMMEA PRATINCOLA, Bonaparte.—*American Barn Owl.*—Mr. Shorten informs me of the capture of our third recorded specimen of this species on April 14, 1880, at Foster's Landing, on the Ohio river, 36 miles above Cincinnati.

165. HALIAETUS LEUCOCEPHALUS, Savigny.—*White-headed or American Eagle.*—A skull of this bird exhumed during the excavations conducted by the Literary and Scientific Society of Madisonville, Ohio, in an ancient cemetery near that place, is a specimen of the earliest taxidermy (as we now use the term), on record. It had been stuffed with blue clay, and this clay as well as some of the bones of the skull, showed distinctly the staining of verdigris, doubtless due to the oxidation of a copper chain or band by which it had been suspended or held in place. This skull was preserved in ashes along with other relics of the former owner, and perhaps once decorated the breast of some valiant brave or dusky maiden.

166. (RHINOGRYPHUS) CATHARTES AURA, Illiger—*Turkey Buzzard.*—Two sets of the eggs of this species, well advanced in incubation, taken by Mr. Quick, at Brookville, Ind., May 14 and 15, 1879; and a third set, fresh, May 22, 1880. The first set was found by the side of a log on the ground; the second in a hollow sycamore snag, six feet from the ground and forty feet from the only entrance which was at the top of the snag; the third four feet from the ground in a cavity in a red-oak tree. Their measurements are as follows: 2.90x1.95; 2.70x1.90.—2.95x1.95; 3.10x1.85.—2.75x1.94; 2.75x2.00.

170. MELEAGRIS (GALLOPAVO) AMERICANA, Coues.—*Wild Turkey.*—The most satisfactory evidence yet adduced of the former occurrence of this species here, is the finding of numerous specimens of its bones during the excavations in the pre-historic cemetery near Madisonville. These bones occurred in the circumscribed deposits of ashes, called "ash pits," along with the bones of various other animals, several of which, like the present species, have now become extinct in this region; many of the bones were utilized in the manufacture of awls, beads and other articles of utility or ornament.

172. BONASA UMBELLUS, Stephens.---*Ruffed Grouse; Pheasant.*---An examination of the crop and gizzard of a Ruffed Grouse, taken by the writer, at Brookville, Ind., on May 10, 1879, revealed the following articles of fare: In the crop were three large beetles (*Phyllophaga hirsuta*) entire, but slightly crushed; numerous green seed-pods of the Bloodroot (*Sanguinaria canadensis*); and a large mass of the leaves of

White Clover (*Trifolium repens*) and Ground Ivy (*Nepeta glechoma*). The gizzard contained numerous seed stones of the Black Gum tree (*Nyssa multiflora*) and remains of several of the beetles before mentioned.

—. TRINGA FUSCICOLLIS, Vieillot.—*Bonaparte's Sandpiper.*—Two specimens, the first recorded from this vicinity, taken September 6, 1879, near Glendale, Ohio, by Mr. J. B. Porter; both were males.

189. CALIDRIS ARENARIA, Illiger.—*Sanderling.*—An additional specimen noted by Mr. Shorten, taken on the Ohio, opposite Cincinnati, in September, 1879.

192. TOTANUS SEMIPALMATUS, Temminck.—*Semi-palmated Tatler; Willet.*—A specimen now in Mr. Butler's collection, was shot on the *roof of a barn* near Brookville, Ind., in 1878.

205. NYCTIARDEA GRISEA NÆVIA, Allen.—*American Night Heron.*—Two specimens, both full-fledged young of the year, taken on the Little Miami, near Madisonville, June 18, and July 6, 1879, its first record here outside the migrating seasons. I am indebted to Mr. Charles Tompkins, of Madisonville, for one of the above specimens, which is now in my cabinet.

207. ARDETTA EXILIS, Gray.—*Least Bittern.*—An additional specimen taken at Madisonville, September 19, 1879.

213. PORZANA NOVEBORACENSIS, Cassin.—*Little Yellow Rail.*—Mr. Butler notes the rather common occurrence of this species near Brookville, in September, 1879, several specimens being caught by hand.

245. GRACULUS DILOPHUS FLORIDANUS, Coues.—*Florida Cormorant.*—Two or three specimens noted by Mr. Quick and myself, in September, 1879, on the Whitewater and Little Miami rivers.

255. PODILYMBUS PODICEPS, Lawrence.—*Pied-billed Dabchick; Water Witch.*—The stomach of a specimen taken September 20, 1879, at Madisonville, contained a mass of hair-like feathers, nearly as large as a pigeon's egg, interwoven with which were numerous elytra of beetles, several spiders and remains of aquatic larvæ.

ARCHÆOLOGICAL EXPLORATIONS NEAR MADISONVILLE, OHIO.

PART II.

SEPTEMBER 1 TO DECEMBER 8, 1879.

On September 1st, three ash pits were opened, and two skeletons exhumed; the latter were lying horizontally at a depth of eighteen inches, and the cranium of one was missing.

Friday, September 5th, two more skeletons were found, both of adults. One of these was 5 feet 3 inches in length, while the other, exclusive of the head, which was missing, measured 5 feet 4 inches. The hands of the latter, judging from the position in which they were found, had apparently been cut off before burial and laid upon the chest. Immediately north of this last skeleton was a fire-place or hearth 10 feet in length, 4 feet wide and 3 feet deep, containing calcined limestone, broken boulders, sherds, ashes and animal remains; the earth in and on the sides of the excavation was baked and burned red. Two similar hearths were found on the 8th and 9th, and two skeletons exhumed.

One of these skeletons was lying in a horizontal position, two feet below the surface, and directly under the decayed trunk of a walnut tree, which was 3 feet 10 inches in diameter.

Several ash pits were next explored, and on Saturday, September 13th, a group of four skeletons was found, of which two were those of children, about 8 or 10 years of age.

The trunk and cranium of one of the adult skeletons exhumed to-day extended under an oak which measured 5 feet 9 inches in circumference, two feet above its base.

In one of the ash pits opened this week was found a curious inscribed stone, of which an illustration is given (fig. 24).

It is an irregular piece of fossiliferous limestone of a reddish brown color, as though it had been stained by being deposited in a ferruginous soil, the fracture on the edge showing the natural color of the limestone; the markings are incised lines and the pointer is the most prominent figure; the other lines are plainly visible although the surface is much weathered and worn. The stone and markings, perhaps, have reference to the pit of carbonized maize,* near which it was

* See first paper, No. 1, Vol. 3, this Journal, pp. 40-68.

found, and it is to be regretted that the exact position in which it originally laid was not noted.

The characters engraved on the stone were not noticed until after it had been removed from the grounds, and it was then too late to locate it any closer than one of the ash pits opened on the 8th of September.

On Monday, September 15th, a group of eight skeletons and four ash pits were found. The following week was spent in exhuming this group,

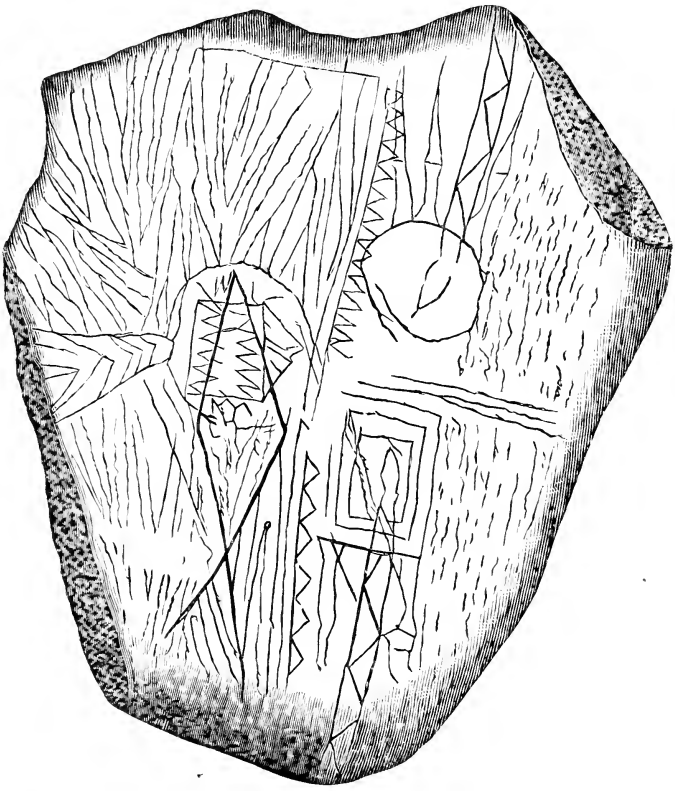

Fig 24. (W. C. Rogers' collection.) Inscribed Stone from Ancient Cemetery, Madisonville, Ohio.

the members of which were disposed as follows: the first skeleton was an adult, lying horizontal, head east; length 5 feet 5 inches; depth 18 inches. The second was also an adult, lying directly over the pelvis of the preceding skeleton, with head towards the south, face upward, at a depth of 16 inches, the length of this skeleton was 5 feet 2 inches. An ash pit was found in the angle formed by the lower extremities of

skeletons Nos. 1 and 2, some large fragments of pottery, flint and bone implements were taken from this pit. A second ash pit was next opened, located 8 inches north of the first. The third skeleton was an adult, 6 feet in length, lying horizontally, head southwest, at a depth of two feet. A broken vessel was found with these remains. The fourth was an adult, 5 feet in length, head directed east. No. 5 was an immature skeleton, head southeast, face toward the southwest; a perfect vessel was taken from near the top of the head. No. 6 was another adult skeleton, 6 feet in length, head southeast, and about 12 inches from No. 5; depth 20 inches. About 6 inches northeast of this skeleton a third ash pit was found, which contained several implements made of elkhorn, some bone cylinders, and other relics. Ash pit No. 4 was located just north of ash pit No. 2. From this pit several charred corn cobs were taken. In the leaf-mold between these two pits, a fragment of an iron hatchet or tomahawk of peculiar pattern was found, about 13 inches below the surface; whether this belongs with these remains or is a surface relic of more modern date, is of course uncertain; circumstances, however, and the appearance of the article, point strongly to the latter conclusion, as it is the only iron implement yet found, did not come from an ash pit or a grave, and does not show sufficient corrosion to warrant the belief that it is as old as the human remains.

Monday, September 22, two skeletons of children, in horizontal position, heads northeast, were found; one about two years and the other probably twelve years of age. Both lay face downward, the younger on top, with its face resting on the nape of the other's neck; a small broken vessel lay near their feet, and at their heads a larger nearly perfect one; a small strip of copper was found near by. An ash pit of the usual character was also explored.

September 23d, the skeletons of two more children, lying side by side, heads directed north and faces upward, were found; then another ash pit from which was taken an ornamented grooved hammer; next at a depth of 20 inches an adult female skeleton, 5 feet 5 inches in length, lying horizontally, head southwest, with the hands folded over the pelvic bones.

On Wednesday, September 24, a very singular group of remains was found; first was the skeleton of an adult female in horizontal position, head southeast, with small (fœtal) bones in the pelvic region; at her feet was a confused mass of bones, from which five crania were removed, three of which were found face downward and the other two face upward.

On Thursday, 25th, a very interesting ornament was found with the skeleton of a child (fig. 25).

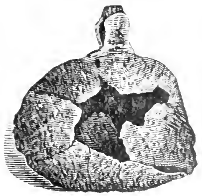

Fig. 25.

It is made of a single piece of copper of irregular shape, the edges of which have been brought together so as to form a ball, or rather like a sleigh bell, leaving an irregular opening on one side. A small hole was punched through the top and a strip of copper doubled up and the ends pushed through the opening from the inside, forming a handle. Inside this bell is a fragment of copper, about the size of a large pea, and when the ornament is shaken it produces a rattling or tinkling sound. It is without question one of the most unique specimens of aboriginal workmanship ever recovered.

On Friday, September 26th, another female skeleton was found, lying horizontally, head southeast; length 5 feet 1 inch; probable age 24 years; with these remains two large bone cylinders or beads were found, one on each side of the neck. From this date, until October 7th, nothing but ash pits were discovered; these, ten in number, were explored and found to contain many interesting relics.

Fig. 26. Earthen Vase, ¼th size. (Joseph Cox, Jr.)

On October 7th, three skeletons were uncovered; the first that of a child, about six years of age, in horizontal position, head east, at a depth of fourteen inches; the next, an adult female, length 5 feet 2 inches, head northeast, depth 20 inches; a small vessel was found at

the right side of the cranium. The third skeleton, an adult male, was lying in the same position, at a depth of 22 inches. From near the right side of the head was taken a vessel, with a base or pedestal, the only one of this peculiar form yet found (fig. 26); beneath the cranium was a small discoidal stone and a bone fish hook.

The principal discoveries during the next ten days were ash pits of about the usual size and contents, excepting one opened on the 17th, which was oblong, and larger than usual, being 8 feet in length, 6 feet wide and 4 feet 3 inches deep.

On October 18th, a group of ten skeletons was discovered. The first was an adult female, 5 feet 6 inches in length, in horizontal position, head south, with a small, nearly perfect vessel at the head. Next was an adult male, in a doubled-up position, head west. On removing this skeleton, the lower extremities of a third were found; following these bones in an easterly direction, the spade struck a vessel which had been deposited near the left hip. After taking this vessel out, another skeleton, lying north and south, with head toward the south, was found, the lower extremities of which extended over the chest of the third skeleton, which was lying east and west. No. 5 was a large male skeleton, 6 feet 3 inches in length, lying horizontally, head north-west, considerably deeper than Nos. 3 and 4, but about the same level as the first and second, and immediately below this was another (No. 6), extending eastwardly, the cranium of which was missing; several ash pits were located in this trench, from which many fine relics were taken. On the 23d, skeleton No. 7 was uncovered at the same depth as No. 6, head northwest.

From an ash pit opened on Friday, was taken a singular ornament made of elkhorn, which may have been utilized as a comb (fig. 27).

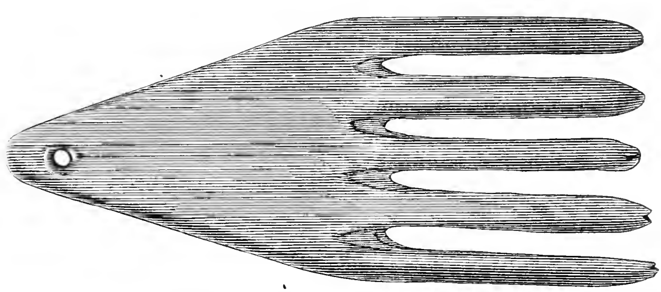

Fig. 27. Elk Horn Ornament. (E. A. Conkling.)

Three skeletons, south of the group, were taken out on Saturday and Monday.

On Tuesday, October 28th, skeleton No. 8 was found, an adult male, with head southeast, length 5 feet 8 inches, depth 15 inches. A broken vessel was found at the right of the head, and on the left side a pipe made of limestone, well finished, and carved to represent the head of some animal (fig 28). A copper ornament was also found at the right side of the neck (fig. 29).

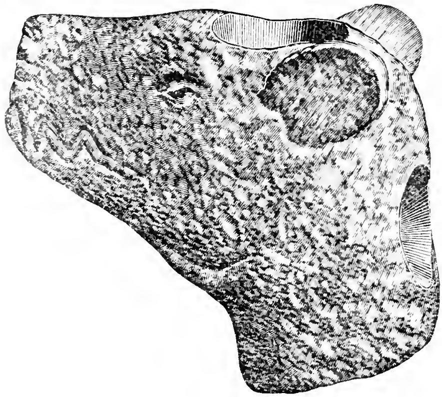

Fig. 28. Pipe. (P. G. Thomson.)

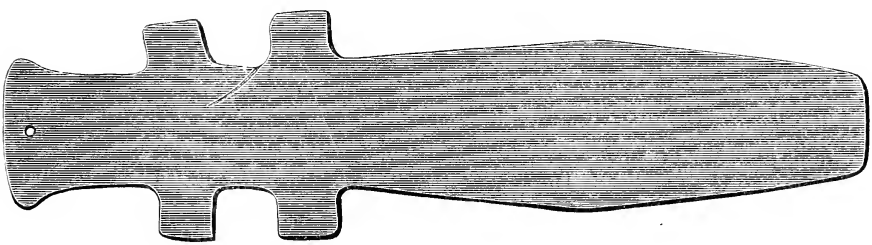

Fig. 29. Copper Ornament. (H. B. Whetsel.)

This relic, which has two bars or cross arms, is made of a very thin piece of copper, rolled or beaten evenly, with small perforation at one end, doubtless for suspensory purposes; and excepting the double arms, somewhat resembles the copper ornament found in the stone graves in Tennessee, described and figured in the eleventh annual report of the Peabody Museum of American Archæology and Ethnology, p. 307.

The total absence in this cemetery, of any evidences of contact with European races, of which fact mention was made in our first paper, makes the remarks and conclusions of Prof. Putnam, relative to the Tennessee ornament, very appropriate in this connection.

"The cross-like form of this ornament may give rise to the question of its derivation; and had any article of European make, such as glass beads, brass buttons, etc., so common in Indian graves, subsequent to contact with whites, been found in any one of the hundreds of graves I opened in Tennessee, I should consider the form of this ornament the result of contact with the early missionaries; but, from the total absence of articles denoting such contact, I think it must be placed in the same category with the 'tablet of the cross' at Palenque, and be regarded as an ornament made in its present form, simply because it is an easy design to execute, and one of natural conception."

On Wednesday, 29th, the skeleton of a child about four years of age was found, lying horizontally, head north, at a depth of twenty-one inches. A broken vessel lay at the right side of the cranium.

On October 31st, two skeletons were uncovered. The first was that of a child about four years of age, and in the same position as that found on the 29th, depth 3 feet; the other skeleton was an adult male, head south, length 5 feet 8 inches, depth 16 inches. A vessel also accompanied these remains.

Several ash pits were explored during the following week, but no skeletons were found until November 7th, when that of an adult male was exhumed; position horizontal, head east, length 5 feet 6 inches, depth 15 inches. An ordinary vessel was found on the right side of the head.

The excavations were now along the edge of the ravine; the depth at which many of the skeletons were found was but a few inches, and the depth of leaf-mold over the ash pits had diminished to 10 and 12 inches. This is accounted for by the denudation of the surface of the slope by the elements, the soil being carried into the ravine. It is very evident that at the date of these burials, this ravine was much less extensive than at present, and has since extended into the plateau some 250 feet. This will also account for the numerous scattered human remains found in the ravine, which attracted the attention of collectors for several years previous to the discovery of this cemetery.

It is also noticeable that the depth of the ash pits below the first layer of leaf-mold do not vary materially from those in other portions of the plateau.

On November 18th, a group of twelve skeletons and three ash pits were found near the edge of the ravine. The first was a child about four years of age, lying horizontally, head east, face upward, at a depth of only six inches below the surface. Two feet northeast of the

first was the skeleton of another child, of about the same age, and in the same position. The third, was that of another child, about six years of age, lying about twelve inches west of the feet of the previous two skeletons, head directed south. In the space between the body of No. 3, and the feet of Nos. 1 and 2, was found a grooved stone hammer. About two feet north, the next skeleton was found at a depth of ten inches. This was an adult female, in an extended position, body inclined with the extremities deeper and the tibiæ flexed to the south, at right angles to the rest of the skeleton. No. 5 was located four and one half feet northwest of the knees of No. 4, depth seventeen inches, and was the remains of an adult male, six feet in length; position horizontal, head south, face upward. The sixth skeleton was an adult female, length 4 feet 10 inches, lying horizontally, head north, at the same depth. No. 7, also an adult, 5 feet 4 inches in length, with head directed northwest. In the space between Nos. 4 and 5, at a depth of seventeen inches, No. 8, the skeleton of a child about four years of age, was next exhumed, head northwest. Two feet south of the head of this skeleton, a perfect vessel was found. Owing to the irregular disposition of these skeletons, it is difficult to state with which skeleton this vessel was originally deposited, unless it is supposed that the deeper burials were old interments, and that No. 4 was subsequent, and the tibiæ flexed to avoid contact with or disturbance of the previous interment.

No. 9 was the remains of another child, probably six years of age, and was quite near the edge of the ravine, and but nine inches from the surface. It was in a horizontal position, head east, and face upward. No. 10, an immature skeleton, age about fourteen years, was lying horizontally, head south, at a depth of fourteen inches. With these remains was found a vessel at the right of the cranium; a boulder and a stone flesher near the lower extremities. No. 11, another child, about ten years of age, head south, at a depth of twenty inches. Under the right ilium of this skeleton was a shallow dish-shaped vessel, with flaring edge, different from any yet found in this cemetery, but somewhat similar in shape to one of the vessels found in the stone grave mounds in Tennessee, specimens of which we have been enabled to obtain through the courtesy of Prof. F. W. Putnam, of the Peabody Museum of American Archæology and Ethnology. No. 12, the farthest north of this group, was an adult, in horizontal position, head south; length 5 feet 5 inches, depth 15 inches; a stone skin dresser and round boulder, similar to the relics found with No. 10, were found near the right side.

Between this skeleton and the edge of the plateau three ash pits were found and explored. In the first one the layer of leaf-mold was but ten inches, the second layer was twelve inches of sand and ashes, and below this fifty inches of ashes; numerous shells, pot sherds, animal bones and some flint implements were found in this pit. The second ash pit had three feet of sand in the second layer, and but sixteen inches of ashes. The third pit, eight inches of sand and forty-four inches ashes. A few words explanatory of the method of making these excavations may, perhaps, be in place, in order to make clear the reason why skeletons were found at different dates in the same excavation, as is the case in this group. The workman employed by the Society, who is a very careful and reliable person, is instructed in all cases of the discovery of skeletons, to partly uncover them, so as to determine the length and direction, but under no circumstances to remove them until after they are viewed *in place* by Dr. Metz, the Superintendent, or some other member of the Society who may be on the ground. In this manner all the remains at one depth are discovered, and upon their removal the excavations are continued beneath that plane, until the bed of undisturbed gravel is reached, below which no skeletons or relics have been found.

In several instances, three or four skeletons have been exhumed, overlying each other at different depths.

On Monday, 24th, the ash pit discovered on Saturday was explored, and in addition to the usual contents, a small piece of copper was found; three feet west of the ash pit, the skeleton of a child about six years of age was uncovered, position horizontal, head southeast, face upward, depth 18 inches. On Wednesday, 26th, the skeleton of another child, of about the same age, was discovered in the same position, with head directed south, depth 17 inches. These remains were deposited directly over an ash pit.

Thursday, November 27th, an ash pit near the edge of the ravine was opened: Two feet west of the ash pit the skeleton of a child was found, lying horizontal, head south, and face upward, depth fourteen inches. A small broken vessel lay at the top of the head. Two immature skeletons, probably 16 or 18 years of age, were next exhumed, about 17 feet from the edge of the plateau. The bones were intermingled in a somewhat regular oblong arrangement, with a cranium at each end of the heap, both skulls facing north. Under one of these skulls was found a peculiar narrow-necked vessel (fig. 30), originally with four handles. Immediately under these remains was an ash pit.

Including those mentioned, eight ash pits were opened during the

week ending November 29th, and quite a number of fine bone implements were taken out; most of these pits contained a layer of sand from ten to twelve inches deep, between the leaf-mold and the ashes.

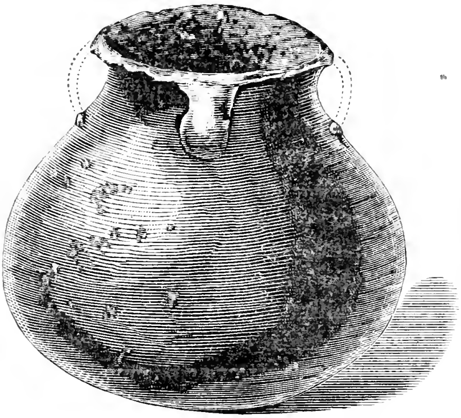

Fig. 30.

Monday, December 1st, the skeleton of an adult female was exhumed, twenty-nine feet from the edge of the plateau. These remains

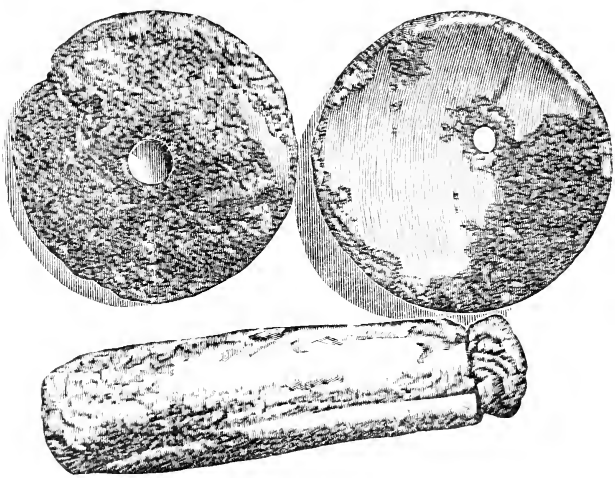

Fig. 31. Shell Ornaments (Mr. Ferris).

were placed in a horizontal position, head northwest, depth 1 foot 10 inches, and measured 5 feet 6 inches in length; the lower extremities were flexed on the thighs. Two perforated shell disks about the size of a silver dollar, and a pendant made of the hinge of a large shell, with a deep groove at the smaller end, were found near the neck (fig. 31); a stone flesher was also found with this skeleton.

An adult male skeleton was exhumed to-day; length 5 feet 8 inches, position horizontal, head southeast, depth 1 foot 10 inches. Under this skeleton was a well defined, circular excavation, 3 feet 7 inches in diameter, and 3 feet 8 inches deep, similar to the ash pits, but which contained nothing but clear sand. Neither ashes nor relics were found in it. An adult male skeleton was exhumed on Thursday, December 4th, position horizontal, head south, depth 1 foot 4 inches; this was lying over an ash pit. Friday, December 5th, an ash pit was opened remarkable for the quantity of ashes and its unusual depth, which was 6 feet 10 inches. The layers were as follows: leaf-mold and sand, 28 inches; pure ashes, 26 inches; ashes and sand, 28 inches.

From this pit was taken a fragment of a polished, fossiliferous limestone pipe, and the usual flint and bone implements. Two skeletons were exhumed to-day; the first was that of an adult male, length 5 feet 10 inches, position horizontal, head south, depth 1 foot 9 inches; beneath the occiput a flat harpoon, or fish spear, made of elkhorn, was found. The second skeleton was 5 feet 4 inches in length, lying in the same position as the first. Nine inches south of the cranium of the second skeleton was an oblong or elliptical vessel of about one half gallon capacity.

On Monday, December 8, an adult female skeleton, 4 feet 5 inches in length, was found; position horizontal, head north, with broken vessel at left side of cranium; depth 7 inches. The next skeleton was that of an adult male, 5 feet 10 inches in length, horizontal, head south, depth 13 inches. The third was an immature skeleton, probably sixteen years of age, position also horizontal, head southeast, depth thirteen inches; with a broken vessel at the top of the head. These three interments were remarkably shallow, with barely enough earth to cover them.

On Thursday, December 11th, an adult skeleton was discovered, length 4 feet 4 inches; position horizontal, head south, depth two feet, and lying directly over an ash pit.

On Friday, December 12th, four skeletons, one adult female and three children, about three years of age, were exhumed, all laid in horizontal positions, heads south, except the third child, which was parallel with the three skeletons, but with head to the north. A broken vessel was found at the top of the heads of the two children which were directed south.

On Monday, December 15th, another skeleton of a child about two years of age was found, lying horizontal, head east; depth 1 foot 8 inches, with vessel at vertex.

December 16th, two skeletons were exhumed, one in horizontal and the other in a sitting position. Several skeletons and three ash pits were discovered on the following day, and on Saturday, December 20th, a group of five children, all about three years of age, was found. These skeletons were in a horizontal position, heads south, and lying side by side; depth 1 foot 10 inches: making a total of 15 skeletons exhumed during the week.

From December 22d to December 27th, five adult skeletons, all in horizontal positions, were found, and two pits containing sand and a few relics, but no ashes.

On Monday, December 29th, an adult dwarf skeleton, probably female, was uncovered. It was lying on its side, head south, facing east. The spine of this individual presented an example of a somewhat remarkable pathological condition, the spinous and articular processes of all the dorsal and lumbar vertebra being anchylosed; *the bodies remained free*, with the exception of two in the lumbar region, which were connected only by a thin band of osseous tissue. The lumbar vertebra were in their turn solidly united with the sacrum, and the latter bone with the ilia. Several of the carpal and metacarpal bones had also become united into a solid bony mass, and the atlas was connected with the skull in a similar manner, altogether making this probably one of the most interesting cases of disease of the osseous system on record.

The skeleton of a child about three years of age was also exhumed to-day, and a singular collection of bones disposed as follows: a skull, resting on its base, facing south, over which were placed the two ossa innominata, and at its side three femurs and one tibia; no other bones were found; depth 2 feet 3 inches. Tuesday, December 30th, a group of five skeletons was discovered, one an adult male, six feet in length, and four of children about three or four years of age. All these remains were in horizontal positions, side by side, and about the same depth, viz.: 1 foot 9 and 10 inches. Two broken vessels and two stone fleshers were found with this group.

December 31st, an ash pit, 3 feet in diameter and 5 feet 2 inches in depth, was opened. The layers were as follows: leaf-mold and sand, 24 inches; ashes, 38 inches; contents, pottery sherds, *Unio* shells, burnt limestone, animal remains and a few flint implements.

[To be Continued.]

DESCRIPTION OF FOUR NEW SPECIES OF SILURIAN FOSSILS.

By S. A. Miller, Esq.

Eucalyptocrinus (Hypanthocrinus) egani, n. sp.

(Plate IV., fig. 1, cast of the calyx and the dome; fig. 1*a*, cast of the dome. the canal leading from it, the expansion at the top of the interbrachials and extension above, where it was covered by plates: fig, 1*b*, cast of the body, dome and interbrachials; fig. 1*c*, cast of the canal showing the markings of the plates above the interbrachials, and the evidences of the attachment of the latter to the dome.)

The general form of the calyx is obconical, with a truncated base for the columnar attachment. Height and width about equal. With the brachial and interbrachial plates and arms attached, the form is cylindrico-elliptical. The basal plates form a regular pentagon, upon the sides of which the first radials rest. The first radial plates are hexagonal, longer than wide, and larger than the succeeding ones. The second radials are somewhat quadrangular; the greater width is at the base, which is slightly convex, and rests upon the superior concave side of the first radials. The third radials are hexagonal, the superior side being the shorter, and the lower lateral sides being shorter than the other three. The first supra-radials are pentagonal and less than half the size of the third radials. The second supra-radials are smaller than the first, pentagonal and support the arm plates. The inter-supra-radials support interbrachials. The interradials consist of one large ten-sided plate, having a length more than twice its greatest diameter, and supporting upon its upper face two interradials that support interbrachials.

It will at once be observed, that this formula of the plates is that of *Eucalyptocrinus*, and that the calyx may be distinguished from *E. crassus* only by the more elongated form of the body and plates. Above the calyx, however, the species are distinguished by more marked and decided characters.

The cast of the dome, immediately covering the cavity of the calyx, has a height above the calyx about equal to its diameter. Two little projections, at the top of the calyx, between the interbrachials, remain upon the casts, to show the connection between the arm furrows and the interior of the body. The interbrachials were firmly interlocked with the dome as shown by the widened concave edge and the three slits in each, as well as by the angular and indented surface markings of the dome. The cast of the canal leading from the dome to the top

of the interbrachials has a length about one half greater than the diameter of the dome. It expands rapidly as it approaches the top of the interbrachials, and here we have the evidence in the projections and the furrows, that the interbrachials were firmly interlocked with the plates or pieces that surrounded this canal.

The canal extends above the top of the interbrachials forming a dome, slightly drawn to one side, and having a height about equal to its basal diameter. This dome was surrounded, as it appears from our specimens, by five large plates.

It has been considered, by Prof. Hall, that the genus *Hypanthocrinus* of Phillips, is a synonym for *Eucalyptocrinus*, founded thirteen years earlier by Goldfuss. Angelin and other European authors, however, retain both generic names, referring to the former such species as have an expansion of the canal at the top of the interbrachials, and a dome covering this expansion. Our species possesses all the characters of *Hypanthocrinus*, and I have retained the name, in a subgeneric sense, because there are a number of species constructed upon this plan, which may thus be collectively distinguished from the typical *Eucalyptocrinus.*

This species was collected in the magnesian limestone of the Niagara Group, at Chicago, Ill., by W. C. Egan, Esq., of that city, in whose honor I have proposed the specific name. He very kindly presented some specimens to the Cincinnati Society of Natural History, and to the author.

MYELODACTYLUS BRIDGEPORTENSIS, n. sp.

(Plate IV., fig. 2, a dextral specimen showing the finger-like processes extending over the inner whorls; fig. 2*a*, a sinistral specimen showing the radiate structure; fig. 2*b*, a dextral specimen having the finger-like processes removed so as to show the larger and smaller whorls, and their union at the central part of the disk; figs. 2*c* and 2*d*, showing the radiate structure; fig. 2*e*, magnified view of a fractured specimen.)

This species is possessed of a coiled and radiate structure of an apparently complicated character. The coil is discoidal and both dextral and sinistral, in different specimens. There are nearly four whorls, in the best specimens examined.

The coil consists of a double series of plates which unite at the central part of the disk. From every two plates of the outer series, there arises a finger-like process, which extends over the next inner whorls, toward the center of the disk. Beneath these overlapping finger-like processes there is a passage, inclosed by reason of the whorls being brought into contact by the inner series of plates. The inner series of plates are about one third the size of the outer series, and connect the latter

by means of pores, passing from one to the other. This series of plates is connected by a canal or central opening throughout its length, as is also the larger series.

The radiate structure consists of pores or passage ways from the inner whorls to the outer ones, and commencing at the center of the disk, which, in some of the casts, resembles the spokes of a wheel. A passage way, through each of the finger-like processes, connects each plate of the inner larger whorl, with each plate of the next outer larger whorl, by reason of a bifurcation in the passage way to unite with the two plates, from which the finger-like processes arise. Thus doubling the radiations with each succeeding whorl. The passages from the smaller whorls to the larger ones are very numerous, and taken in connection with the other passages make the circular and radiate structure exceedingly complicated.

All of the specimens are casts, collected by W. C. Egan, Esq., in the magnesian limestone of the Niagara Group, at Bridgeport, near Chicago, Illinois. From the numerous specimens which he collected, he has very kindly presented some to the author, and others to the Cincinnati Society of Natural History.

I regard the affinities of this genus with *Cyclocystoides*, rather than with any other genus known to me. The order Cystoidea has become, however, the receptacle for too many remotely connected genera, and I am inclined to think, that this genus belongs to an undefined order of the Echinodermata. It is certainly not a crinoid, nor is it the finger of one.

In 1852, Prof. James Hall proposed the generic name *Myelodactylus*, to distinguish what he supposed to be the arms or fingers of an otherwise unknown crinoid, the remarkable feature of which, he said, is the foramen or medullary canal penetrating the column of joints. He described *Myelodactylus convolutus* as "composed of a single series of thin joints, which are slightly nodulose or tubercular on the back; ends of the joints somewhat semicircular or crescent-form, with the extremities truncated; tentacula composed of numerous rounded or slightly nodulose joints, which are attached to the truncated extremities of the finger-joint by a tendon inserted into a perforation in the joint; fingers usually incurved or convolute; plates penetrated vertically by an oblong quadrangular canal, through which probably passed a strong tendon connecting the whole together; surface of each plate marked by a pentagonal depression, within which are elevated ridges, the whole intended for the strong attachment of muscular fibres connecting the plates; outer edge of the plate, upon the back, marked by two or

sometimes three minute grooves or perforations communicating with the muscular impression upon the upper surface."

Angelin referred three species to the genus *Myelodactylus*, viz., *M. gracilis*, *M. heterocrinus* and *M. interradialis**. He described the generic characters as follows : "Corpus tenerum, elongatum. Calyx cyathoideus. Basalia tria. Parabasalia quinque, polygona. Radialia primaria quinque, unicam zonam formantia ; secundaria per duas series ; superiora triangula, brachiifera. Interradialia duo. Brachia longissima, subfiliformia, repetito-dichotoma, articulis simplicibus. Tubus ventralis distinctus, articulatus. Columna crassa, convoluta, articulis tenuissimis, cirrhis numerosis, moniliformibus."

His species are all small and slender, and very much resemble some species of *Heterocrinus*. They certainly have no generic relation with *Myelodactylus*.

PALÆASTER MIAMIENSIS, n. sp.

(Plate IV., fig. 3.)

Pentagonal; rays about one and a half times the diameter of the body, or about 9-10ths of an inch; diameter of the body about 6-10ths of an inch; breadth of a ray at the point of junction with the body a little more than half the diameter of the body, or about 7-20ths of an inch; rays obtusely pointed.

Marginal plates wider than long, and numbering about twelve in the length of half an inch from the body. Two marginal plates form the junction of the rays. Ambulacral furrow wide, the plates being more than twice as long as wide. There are about 18 ambulacral plates in a length of one half inch, and each one is provided with an angular ridge tapering from the marginal plates to the furrow.

This species is founded upon a single specimen, showing only the ventral part of the body, and hence the other parts are unknown. It bears some resemblance to *P. granulosus*, but on comparison with good specimens in my own collection I found it essentially distinct. In the marginal plates it bears some resemblance to *P. longibrachiatus*, though even in this respect the two species are distinct.

The specimen was found near Waynesville, on the Miami river, in the upper part of the Hudson River Group, and belongs to the collection of I. H. Harris, Esq., of that place.

BYTHOPORA NASHVILLENSIS, n. sp.

(Plate IV., fig. 4, natural size; fig, 4*a*, magnified view.)

In this species the branches are cylindrical, of nearly equal size, and

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* Iconographia Crinoideorum in stratis Sueciæ Siluricis fossilium.

frequently bifurcate at right angles as well as at all other angles. The diameter of a branch is from 1-4 to 1-2 a line. The cells are usually arranged in longitudinal lines, though this arrangement does not exclusively prevail. The cell mouths are elliptical and separated by nonporiferous spaces. A limited space within the bifurcation of the branches, and upon the lower side of the branches is furrowed and destitute of cell mouths.

This species is distinguished from *B. fruticosa* by the mode of branching and by the shape of the cell mouths. The cells are also much more numerous, in *B. fruticosa*, than they are in this species.

This species is from my own collection, and was found in the Trenton Group, near Nashville, Tennessee. *B. fruticosa* was described from a specimen which I collected in the Hudson River Group, at Cincinnati, and at the time of its illustration and description transferred to Mr. C. B. Dyer. Mr. U. P. James never saw the specimen, unless Mr. Dyer has shown it to him since it was illustrated and described, and the description which Mr. James had written of a fossil under the name of *Helopora dendrina* does not apply to *B. fruticosa.*

REMARKS ON THE TRENTON LIMESTONE OF KENTUCKY, WITH DESCRIPTIONS OF NEW FOSSILS FROM THAT FORMATION AND THE KASKASKIA (CHESTER) GROUP, SUB-CARBONIFEROUS.

By A. G. Wetherby, A.M.,

Professor of Geology, University of Cincinnati.

No list of fossils collected from the heavy-bedded limestones along the Kentucky river, in Mercer, Garrard, Jessamine and adjoining counties, has, up to this time, been published. Traveling south, on the line of the C. S. R.R., we pass through many cuts exposing the typical, blue, thin-bedded Cincinnati limestones and shales, the last of these cuts being that at Roger's Gap, about sixty miles directly south of this city. Here the broken country suddenly disappears, and we enter at once upon the renowned blue grass region, justly celebrated for its stock-raising advantages.

No more striking change in topographical features can be found in the State of Kentucky, than that which is here met. The numerous ridges, hills and gullies which have characterized the route, all the distance from Cincinnati, give way at once to a comparatively level and

fertile country. The cuts become few and insignificant, but an attentive study of the lower third of the deeper ones, and the entire section of others, seems to prove what has already been so well indicated by the topography, that we are gradually approaching a very different formation. Instead of the continued alternation of thin-bedded limestones and shales, the latter become insignificant in ratio to the former, and we finally reach the heavy-bedded limestones of the Trenton Group, which first appear in considerable force at the Lexington quarries, eighty miles south of Cincinnati.

The lower strata here exposed begin to exhibit the light color, and more compact texture, which are so characteristic of the Trenton limestones further south at High Bridge. Beyond Nicholasville, and within three or four miles of the Kentucky river, outcrops of these light-colored limestones, somewhat shaly and cherty at top, begin to appear. These rocks have but little dip, and as the elevation at Section 11, C.S.R.R., three fourths of a mile north of Nicholasville, is 957 feet above tide-water, or 525 feet above low-water of the Ohio, and the top chord of High Bridge, 765.7 feet above tide-water, or 333.7 feet above low-water of the Ohio, we have a vertical section of these rocks 191.3 feet in thickness, between Nicholasville and the top of the Kentucky river gorge, which furnishes an additional section of nearly 300 feet, making in all an exposure of nearly 500 feet of rocks, none of which, I am quite satisfied, is higher than typical Trenton. These rocks present much the same variation that they do at points where I have studied them in Tennessee, though no section that I have seen in the latter State, reaches a point so low in the series as the bottom of the gorge of Kentucky river, or the lower part of Dix river.

In this connection it seems desirable to consider the section of the Trenton Limestones of Tennessee, as arranged by Prof. Safford in his excellent geology of that State. These divisions have local names, but they represent well-marked sections of the Trenton as there exhibited, and may be indicated, in part at least, by their equivalents in the Kentucky section now under consideration. They are, in descending order, as follows: *Carter's Creek Limestone*—A heavy-bedded, light-blue or dove-colored limestone, often gray in the upper part. Thickness from 50 to 100 feet. *The Glade Limestone*—A stratum of thin-bedded, light-blue, flaggy limestones, marked by the "Cedar Glades." Thickness at maximum 120 feet. *The Ridley Limestone*—A group of heavy-bedded, light-blue or dove-colored limestones. Maximum thickness 95 feet, as observed by Prof. Safford. *The Pierce Limestone*—A group of thin-bedded, flaggy limestones, with a heavy-

bedded layer near the base. Prof. Safford describes these rocks as "abounding in Bryozoa." Maximum thickness 27 feet. *The Central Limestone*—Thick-bedded, cherty limestones, of a light-blue or dove-color. This bed is the lowest exposure in the Central Basin of Tennessee, and is described by Prof. Safford as about 100 feet in thickness. Immediately above the Carter's Creek Limestone of this section, comes the Orthis Bed of Prof. Safford, which is the lowest member of his Nashville—Formation IV. The relations of this bed to the general geological column are of such high interest, that I venture to examine the subject of its fossil contents.

Prof. Safford has furnished us a list of seventeen species* belonging to this group, and including *Brachiopoda*, *Gastropoda*, *Lamellibranchiata*, *Cephalopoda*, and *Chætetes.* Of these but three are Hudson River species exclusively. Of the remainder, five are Trenton or Black river; seven are indifferently Trenton or Hudson river, though generally described from Trenton localities; and one ranges to the Chazy. The other two are species of *Cypricardites* from the Orthis Bed. The conclusion to be drawn from this list of species is, that the Orthis Bed, judged by its palæontological characters, is pre-eminently Trenton, and is evidently more nearly related to this formathan to the Hudson River. We may now resume the consideration of the Kentucky river section.

Beyond High Bridge the grade of the road rises 176.1 feet in three and one half miles, and this rise in the grade carries us entirely above the heavy-bedded limestones at the river, to the same rugged and thin-layered mass, which forms the upper part of the section, both here and at Nicholasville. These rocks hold many fossils that belong both to the Trenton and Hudson River Groups, the most common of which are *Orthis testudinaria*, *Chætetes lycoperdon*, *Zygospira modesta*, *Raphistoma lenticulare* of large size, and *Murchisonia bellicincta.* With these fossils are found, however, a much larger number of typical Trenton species, as will be seen further on. These limestones continue to be the surface rock along the line of the railroad nearly to

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* The following is the list given by Prof. Safford: *Monticulipora fibrosa*, Goldfuss, Hudson River; *Strophomena alternata*, Conrad, Trenton and Hudson River; *Orthis lynx*, Eichwald, Trenton and Hudson River; *O. testudinaria*, Dalman, Trenton and Hudson River; *O. subæquata*, Conrad. Chazy to Trenton; *Rhynchonella capax*, Conrad, Hudson River; *Zygospira modesta*, Say, Trenton and Hudson River; *Ambonychia radiata*, Hall, Trenton and Hudson River; *Cyrtodonta gantii*, Safford, Orthis Bed; *Cyrtodonta winchelii*, Safford. Orthis Bed; *Modiolopsis modiolaris*, Conrad, Hudson River; *Murchisonia milleri*, Hall, Trenton and Hudson River; *Cyrtolites ornatus*, Conrad, Hudson River; *Bellerophon punctifrons*, Emmons, Trenton and Black River; *Carinaropsis carinata*, Hall, Trenton; *Orthoceras pertinax*, Billings, Black river; *Endoceras rapax*, Billings, Black River.

Danville Junction, where we have the Black Shale at the surface. At the level of the top chord of High Bridge, and a few feet higher, may be identified that portion of this section most like the Glade Limestone of Safford, and furnishing a surface of country upon which cedars grow. It is not difficult to recognize above this a distinct division which corresponds to the Carter's Creek Limestone. Above this is a bed filled with fossils of the very highest interest, many of which are species found in Safford's Orthis Bed, while others are species not collected outside of Canada, until I found them here. Still above this is the ragged mass of thin-layered limestone, forming the upper part of the section. All these divisions may be passed in review by going south from High Bridge, along the railroad to the top of the divide this side of Burgin, and three and one half miles beyond the Kentucky river.

I have referred the above portion of this section to the Orthis Bed for two reasons. It abounds in silicified specimens of *O. testudinaria*, and it is composed of a silicified limestone that weathers into a red soil, like that of its Tennessee equivalent where I have studied it in Maury county. The rock is a siliceous limestone, with a sandy matrix and carbonate of lime cement. The latter readily dissolves, leaving a somewhat sandy soil, which is, in many cases, strewn with chert and silicified fossils in a fine state of preservation.

The following list contains many of the species collected in this part of the section: A few are yet unidentified. *Calymmene* species not determined. *Leperditia fabulites*, Conrad; *Colpoceras virgatum*, Hall; *Glyptocrinus priscus*, Billings; *Blastoidocrinus carcharidens*, Billings; *Hybocrinus tumidus*, Billings; *Hybocrinus conicus*, Billings; *Amygdalocystites florealis*, Billings; *Amygdalocystites radiatus*, Billings; *Hybocystites problematicus*, Wetherby, herein described; *Cypricardites obtusus*, Hall; *C. cordiformis*, Billings; *Cypricardites*, sp. ined., *Conularia quadrata*, Walcott; *Receptaculites*, sp., exhibiting well many of the characteristic points of structure so ably discussed by Mr. Billings, but not identified with any described species; *O. pectinella*, Conrad; *O. perveta*, Conrad; *O. tricenaria*, Conrad; *O. testudinaria*, Dalman; *Leptæna sericea*, Sowerby; *Orthis lynx*, Eichwald; *Strophomena incrassata*, Hall; *Cyrtolites ornatus*, Conrad; *Murchisonia milleri*, Hall; *Petraia aperta*, Billings; *Streptelasma profundum*, Hall.

This list of fossils is sufficient to identify this part of the section with the Trenton beyond any question whatever, and fixes the fact that the three hundred and fifty or more feet of heavy-bedded lime-

stones below it to the bottom of the Kentucky river gorge, are lower than that part of the Ottawa Trenton studied by Mr. Billings. Further south, and about two miles west of Harrodsburg junction, are several more or less heavily-bedded limestones, containing one or two layers which hold many specimens of very large bivalve Crustaceans; *Leperditia*, *Isochilina*, etc., as yet undescribed. Below these strata, and overlying the siliceous rocks mentioned above, there are thin limestones holding immense numbers of fine Bryozoans, *Ptilodictya*, etc., and numerous specimens of *Monticulipora whiteavesii*, Nicholson, together with other species of *Monticulipora* or *Chætetes*. Its lithological characters and fossil contents are those of Safford's Pierce Limestone; but it does not occupy the same place in the section. The lower part of that portion of the section which I have referred to the Glade Limestone holds great numbers of Gasteropods, among which are very large specimens of *Pleurotomaria subconica* Hall, and an unidentified *Subulites*, more than three inches in length. This portion furnishes a numerous list of fossils of very high interest. The new *Heterocrinus*? which I have described in this paper, came from this part of the section. Below this, nothing of importance has been collected outside of the Cephalopoda, among which are an *Oncoceras*, an *Ormoceras*, several species of *Orthoceras*, *Cyrtoceras* and *Endoceras*. In a very thin parting of cherty limestones, at the very lowest portion of the gorge, are numerous fragments of Trilobites, as well as a few Brachiopods and Corals. While it is not difficult to separate this section into groups, having approximate relations with those of Prof. Safford's Tennessee section, it is not here pretended that this reference has been verified in any case. The lithological characters indicating such an equivalence are more marked, by far, than those evidences to be derived from the fossils. This is even the case in the heavy-bedded limestones of the lower part of the section. The fragments of Trilobites obtained from this portion indicate very low Trenton or even Chazy. I have not been able to give such attention to the study of any of the fossils except those enumerated above, as to enable me to pronounce definitely upon this matter. I trust to be able to explore this interesting field thoroughly during the summer, and to have the good fortune to make a fuller collection of its typical fossils. It is worthy of notice that local faultings and disturbances have made it necessary to proceed with extreme caution.

Immediately on the line of the Cincinnati Southern Railroad, one mile from High Bridge, a locaul faulting has brought down the upper part of the section to a level with the middle of the third. These disturb-

ances are numerous, and often marked on the surface by corresponding elevations and depressions. It is possible, though not without severe labor, to work out the lower part of this section in various directions, as numerous tributaries, of greater or less size, have excavated the limestones to the level of low-water of the Kentucky river. These afford means of reaching all parts of the formation, and obtaining satisfactory collections of its fossils. To the kindness of Hon. Jno. R. Procter, now director of the Geological Survey of Kentucky, I am indebted for suggestions as to the distribution of the Trenton, as the surface formation in his "Siluro-Cambrian" area of Central Kentucky, as well as for information respecting its appearance and fossils at Frankfort. The area marked as Trenton on this map by Prof. Procter, differs very much at the north from what is indicated by this paper, as the first outcrop of this formation in that direction, is made to fall between Nicholasville and the Kentucky river. If this determination rested upon the fossils alone, without consideration of the change in topography and the lithological character of the strata, perhaps nothing would be doubtful, and even as it is, I wish, in acknowledging Prof. Procter's kindness, to say that this paper is to be regarded as suggestive respecting this part of the formation, rather than otherwise, or as being a finished determination. I am, however, personally convinced that the evidences are all in favor of these suggestions, and have little expectation that future studies will alter my conclusions. The collection of Echinoderma enumerated in the list above given is a remarkable one. It embraces not only several of the rarest Crinoids and Cystideans known, but also those of the most anomalous characters, and of the greatest interest, as blending an assemblage of structural peculiarities in one organism, that were finally differentiated into several distinct forms. Among these was the *Blastoidocrinus carcharideus*, Billings, now first found in such a condition as to determine the proper relations of its parts, relations predicted with much accuracy, from the merest fragments, by that astute palæontologist. The new fossil, which I have called *Hybocystites problematicus*, is the first found which so closely unites characters both of the Crinoidea and Cystoidea, with the reference of the former characters to those of an undoubted Crinoid of very near relationship. I feel that the special attention of all earnest students of the fossil Echinoderma should be especially called to the extraordinary characters of this genus, and its close resemblance, in many of these, to *Hybocrinus*, Billings, an undoubted Crinoid ; a resemblance so striking that the sexual question is at once suggested as between the two.

Not less remarkable is a series of specimens, embracing characters belonging both to *Hemicystites* and *Edrioaster*. Of these curious fossils there are a number of specimens, the consideration of which must be left to a future paper. It is also a fact of especial significance, that these strata have furnished several specimens of two species of *Archæocyathus*, a genus not hitherto found outside of the Potsdam and Calciferous. Indeed, the whole group of fossils here associated is of such a high order of interest, that I feel certain my fellow laborers everywhere will be glad to know that they have been brought to light.

Genus Hybocystites, Wetherby.

Generic Description—General outline of the body very similar to that of *Hybocrinus tumidus*, Billings. It consists of series of plates, five each in the first two, arranged as in *Hybocrinus*. As in that genus the lower azygous plate bears a second and a radial upon its upper face. Arms three, one upon each side of the upper azygous plate, and one immediately opposite it.* The plates of the upper series between these arms, on either side, are excavated by a groove that is continued downward, and half or two thirds across the plate of the lower series beneath it.

These grooves meet in the vault at a common point with those of the arms, and form a part of the ambulacral system.

The mouth, or ambulacral orifice, is situated nearly centrally upon the upper surface. The valvular anal opening is placed between the upper azygous plate and the mouth. The arms are deeply furrowed, the grooves being covered in by a series of cuneiform interlocking plates. Pinnulæ not observed. Proboscis or ventral sac indicated by the presence of the upper azygous plate. Column small, round, and placed excentrically as in *Hybocrinus*. Vault covered by plates of which the arrangement can not be determined. There are no evidences of pectinated rhombs or poriferous plates. This genus combines, in a remarkable degree, characters both of the Crinoids and Cystids.

Hybocystites problematicus, nov. sp.

(Plate V., fig. 1, summit or vault; 1*a*, lateral view; 1*b*, azygous side; 1*c*, opposite side; figs. 1 and 1*a*, two diameters; figs. 1*b* and 1*c*, natural size.)

Basals—Five, pentagonal, higher than wide, somewhat convex or tumid in the center, nearly alike in shape and size, resembling, in these particulars, those of *Hybocrinus tumidus*, Billings.

Radials—Five, four large, pentagonal, and alternating with the

* These arms are the right and left posterior and the anterior of most authors.

basals, the fifth small, pentagonal, and resting upon the upper sloping, right surface of the first azygous plate as in *Hybocrinus.*

Of these radials, the one opposite the upper azygous plate, and the one on either side of it bear arms. The other two are flexed inward above, to meet the plates forming the vault or oral surface of the body. They are centrally excavated by a vertical groove, which is continued downward into the basal plates, and which joins the arm-furrows in the center of the vault. The central portion of these plates, adjacent to the grooves, is so raised as to form a prominent ridge which becomes less elevated below. They are covered in by a series of small plates, having the same arrangement as the homologous ones of the arm-furrows. The precise relation of the radials to the vault-pieces can not be determined from the specimens. They are all more or less tumid in the center.

Azygous Plates—Two, the lower hexagonal, alternating with the basals, and forming the fifth plate in the ring with the four large radials. It supports upon its upper right side the fifth radial, and upon the left, the second and smaller azygous plate, which is quadrangular, about equal in size to the adjacent small radial, and not so large as its homologue in specimens of *Hybocrinus* of equal size. The upper surface is not so rounded, nor is it crenulated as in the latter genus.

Arms—Three, composed of a single row of plates, apparently about as wide as high, very deeply excavated on the inner side by the ambulacral furrows, which are covered in by a closely interlocking series of small plates having the same arrangement as those of the two radial grooves above described. In transverse section, as may be seen from figs. 1, and 1*c*, the arms are found to be appressed laterally, so as to give them a flattened appearance. There are no certain evidences of pinnulæ. A more or less obscure furrow is seen upon their outer surface, of which nothing further is known.

Vault—This was evidently covered in by a series of plates between the ambulacra, with the exception of a small space at the inner base of the azygous plate. Their arrangement can not be determined. The small, valvular, anal aperture, is situated upon this side of the ambulacral opening, in the line uniting the mouth and the center of the azygous plate, and about half way between it and the inner edge of the open vault space.

Column—This was round, comparatively small, excentrically situated, as in *Hybocrinus*, and composed of equal, thin segments.

Remarks—The fossils for which the above generic and specific

names have been given, are among the most remarkable and anomalous of the series of Echinoderma that I have recently had the good fortune to discover in the Trenton rocks of Kentucky.

The almost perfect identity of the arrangement of the plates with those of *Hybocrinus;* the three arms; the two ambulacra running down the sides of the body as in the appressed arms of many Cystideans; the valvular anal opening; the presence of a proboscis or ventral sac, as indicated by the prominent azygous plate; and the uncovered area of the vault adjacent to it, all taken together form a mixture of characters not united in any fossil of this difficult class hitherto described.

I have referred it to the Cystideæ with some hesitation, but mainly on account of the anomalous arrangement of the ambulacral system, three rays of which are upright and two appressed, and on account of the position of the anal opening, which is the same as that in *Agelacrinites*, *Hemicystites* and *Caryocrinus*, with the slight modification in position caused by the presence of a ventral sac.

In this remarkable genus are thus combined, to an eminent degree, the characters belonging to those palæozoic forms so aptly designated by Professor Dana as Comprehensive Types. It is by the study of such fossils that we may seek to eliminate the beginnings of those early lines of differentiation, that led to so many distinct forms afterward, when their characters became individually separated, and were borne by independent organisms; nor will the value of this study be lost, should it hereafter be found that these characters have a sexual reference.

Locality and Position—Mercer county, Kentucky, in the upper part of the Trenton Group. Seven specimens.

Genus Hybocrinus, Billings.

(Plate V., fig. 2, view of a nearly perfect specimen with arms; 2*a*, same specimen, another view; 2*b*, larger specimen, lateral view; 2*c*, same specimen, azygous side, showing crenulated and convex upper face of the azygous plate. All natural size.)

I have had the good fortune to discover a number of comparatively well preserved specimens of this species, showing several of its characters much better than Mr. Billings' types. The purpose which induces me to figure them is, however, to enable the student to compare *Hybocrinus* with *Hybocystites* intelligently. An examination of figures 1*b* and 2*c* will show the likeness on the azygous side. A like study of figures 1*c* and 2*a* will assist in understanding the opposite side: while figures 1*a* and 2*b* will show the differences in the lateral views. 1*a* showing the appressed ambulacral groove, cutting the

radial and extending over the suture half way down the basal, while fig. 2*b* shows the ungrooved radial of *Hybocrinus*, and the lower joints of the upright arm supported by it. As may be seen from the figure, the upper azygous plate of *Hybocrinus* is rounded and crenulated at its distal extremity, as well as much thickened.

The form of the plate is sufficient evidence that it supported a strong ventral sac, and the crenulated condition of the articulating upper surface of this plate, indicates the place of the lower exterior openings into this sac. In no case is there any evidence of dome or vault-plates remaining in any of the sixteen specimens so far collected. The body-plates were remarkably thick and heavy, and the upper margin of the radials was so bent inward as to make the vault-space comparatively small.

This is the first discovery of this genus outside the Trenton of Canada, on record, although it is now twenty-four years since Mr. Billings found it there.

Locality and Position—Mercer county, Kentucky, in the upper part of the Trenton group. Sixteen specimens, referred to *H. tumidus*, Billings, and *H. conicus*, Billings (one specimen).

HETEROCRINUS MILLERI, nov. sp.

(Plate V., fig. 3, symmetrical side, three diameters.)

Under basals—Not present, or very minute. In the only other species of this genus closely allied in any of its characters to the one under consideration (*H. juvenis*, Hall), they appear only as small triangular points at the junction of the basals. In both specimens of this species there is no evidence of their presence.

Basals—These are so minute, and so blended with the upper extremity of the column, that it is quite impossible to describe them clearly. In both specimens there is an apparent anchylosis of these plates, forming a solid base upon which rests the first ring of the radial series. This character, which is well shown in the figure, would seem to be abnormal or accidental, were it not for the fact that both specimens are exactly alike in this regard. It is a very marked feature of the species, and at once distinguishes it from any other of the genus hitherto described.

Radials—Five, the three shown, quadrangular, higher than wide, upper and lower articulating surfaces straight and parallel, the plates being slightly wider and thicker at the upper extremity. These plates can only be seen upon the symmetrical side in the specimens studied, and here they are equal in shape and size. The slight widening and

thickening of their upper extremity gives the species a somewhat swollen appearance in this region.

Brachials—Two or three, similar in shape to the radials, the lower one nearly equal to them in size, gradually tapering above. These are followed by five or six other plates of quadrangular shape, very gradually tapering upward, somewhat longer than wide. The seventh or eighth is pentagonal, higher than wide, and upon its upper sloping surfaces, the first bifurcation of the arms takes place. But three of the rays can be clearly traced to this point, and they are bifurcated upon the seventh and eighth plates above the radials.

The equal shape and size of these plates, and the peculiar form of the body, make it somewhat difficult to say where the brachial series ends.

Azygous Plates—These are not shown in either of the specimens studied, but the area is indicated on the under side of the specimen figured, though not so as to make an understanding possible.

Arms—First five, then ten, if all the rays divide as do the three shown. After the second division, the subsequent ones can only be traced in two rays, owing to the manner in which the arms are folded together in the specimen. In one case the right hand portion continues without further division to the eighth plate. The left hand again divides upon the seventh arm plate, and again upon the ninth above this. If there are any further divisions they are not shown. There arise thus, from the divisions of this ray, six arms at the free extremity. If the other rays follow this plan, we shall have thirty arms at the least. It is probable that the number is greater even than this. The arms are slender, very gradually tapering, and much exceed in length those of any other species of the genus of equal size. They are entirely different from those of *H. juvenis*, Hall, the only species with which this one need be compared.

Pinnulæ—There are no evidences of either pinnulæ or the so called "armlets" of other species of this genus.

Column—Round, or very obscurely pentagonal, and much resembling that of *H. juvenis*, Hall, as it is made up of an alternation of single, solid discs, and five small, interradially placed pieces, for a distance of one inch at least below the body. The size of the column is equal to the greatest diameter of the latter. No greater length of the column has been found.

Ventral Sac—Not shown in the specimens studied. As I have found it to be largely developed in *H. constrictus*, Hall, and *H. simplex*, Hall, I have no doubt of its presence in this species.

Locality and Position—Mercer county, Kentucky, in the Middle Trenton as there exposed. Two specimens, one of which is remarkably perfect to the tips of the arms.

Remarks—It is with many doubts that I refer this beautiful crinoid to this genus. In considering these doubts I have carefully compared this with all the other species of *Heterocrinus*.

I have also compared notes on this subject with Mr. Wachsmuth, to whom I sent the specimens for examination, who says, "when I wrote up the *Cyathocrinidæ*, I was in doubt whether I should not place *H. juvenis* under a new sub-genus. The size of the column compared with the body is most remarkable, and I think the arrangement of the plates differs from that of *Heterocrinus simplex*, at least."

In this doubt Mr. Wachsmuth was fully justified, and it is a matter to be regretted that he had not defined this little group, giving it sub-generic rank at least.

I hope to obtain other specimens from which the arrangement of the azygous plates and adjacent rays may be fully determined; but with the evidence at hand it is not at all difficult to separate this species from any hitherto described. The specific name is given in honor of that earnest and indefatigable palæontologist, S. A. Miller, Esq., who has contributed so many valuable writings, not only to Palæontology, but also to the subject of Geology at large.

Scytalocrinus wachsmuthi, nov. sp.

(Plate V., fig. 4, view of the symmetrical side.)

Underbasals—Five, pentagonal, about as wide as high, equal in size and alike in form, the lower, inner surfaces being slightly excavated for the reception of the convex, upper surface of the first columnar disc.

Basals—Five, three hexagonal, slightly higher than wide, and identical as to size and form. The two on the azygous side are heptagonal, being rendered so by the truncation of the upper inner angle of the one on the right of this area, and of the upper angle of that on the left.

Radials—Five, four pentagonal, nearly equal in shape and size, wider than high, regularly alternating with the basals. The one on the right of the azygous area, slightly smaller than the other four, irregularly quadrangular, and somewhat elevated above them. It rests upon the truncated upper surface of the basal below. The upper articulating face of these plates extends entirely across, and is striated or slightly crenulated with fine ridges, radiating from the inner central

portion. The sutures of these plates, with the brachials, gape slightly outward.

Brachials—Five, pentagonal, higher than wide, equal in size and shape. Very slightly constricted laterally in the central portion, the lower faces being equal to those of the radials upon which they rest, the upper bearing upon its sloping sides two arms.

Azygous Plates—Arranged in two alternating rows, the lower plate being upon the right ; it is pentagonal, and abuts upon the upper, right hand sloping side of the basal below, the truncated inner angle of the next one to the right, and the radial immediately over this. The first plate above this, on the left side of the azygous area, is irregularly pentagonal, resting upon the truncated upper face of the basal below, and abutting upon the plate above described, the next one above it in the series upon the right, and against the radial on the left. Above these two the number and arrangement is not well shown.

Arms—Ten, composed of a single series of plates which are cuneiform below, but lose this character above, becoming of equal thickness from side to side of the arms. The sutures between these plates are thus oblique to the axis of the rays below, but cross it at right angles above. These plates are slightly wider in the center of the arms, so that the latter taper very gradually above and below this region. There are about fifty of these plates in each arm, which undergo no divisions, all being simple throughout.

Pinnulæ—The few joints of these remaining are short and stout, but not in a condition to indicate anything further.

Column—Small, round, composed of equal thin pieces, radiately striated upon their articulating surfaces, and perforated by a circular canal.

Locality and Position—Pulaski county, Kentucky, in sub-carboniferous rocks of the age of the Kaskaskia (Chester) Group.

Remarks—This species has the arm structure of typical *Graphiocrinus*, from which, however, it differs totally in the arrangement of the body plates, which is that of *Poteriocrinus*, or of that well-marked division of this genus established by Wachsmuth and Springer, under the name *Scytalocrinus*, from which it differs only in the fact that the underbasals are not " bent upward." As these authors have, however, referred the *Poteriocrinus wetherbyi*, S. A. Miller, in which the arrangement of the underbasals is identical, to *Scytalocrinus*, I do not hesitate to place this species in the same division, which might be very properly raised to generic rank.

The specific name is given in honor of Charles Wachsmuth, of Bur-

lington, Iowa, well known as a student and collector of the Crinoids. and author of the *Revision of the Palæocrinoidea*, one of the most important works yet issued, treating of this difficult group of the Echinoderma.

Scaphiocrinus spinifer, nov. sp.

(Plate V., fig. 3, symmetrical side.)

Under Basals—Not shown in any of the specimens thus far collected.

Basals—Five, hexagonal, three being slightly higher than wide, pointed above, and semicircularly truncated below. The one on the right of the azygous side is truncated above for the support of the contiguous radial, and laterally where it meets the lower plate of the azygous series. The one on the left of this area is similar to the three first described, but slightly narrower and longer.

Radials—Five, pentagonal, nearly equal in form and size, the one on the right of the azygous area slightly smaller than the other four. These plates are all truncated above and pointed below, the pointed lower extremity being coincident with the basal sutures, except in the case of the one noted above, of which the lower extremity rests upon the basal as in typical *Poteriocrinus*. The upper articular face of these plates extends entirely across, and is their widest part. This face has, near its outer margin, a longitudinal furrow, which extends about two thirds its length.

A similar groove occupies a like place in the lower articular surface of the brachials, and these doubtless are the points of attachment for some portion of the apparatus by means of which the arms were moved outward, this freedom of motion being indicated by the gaping suture joining the radials and brachials.

Brachials—Five, pentagonal, about as wide as high, equal in size, laterally constricted, the upper outer side, below the articulating surfaces prolonged into a blunted or round-pointed spine, a character repeated in each of the bifurcating plates succeeding the brachials. These form rows of spines around the specimens as may be seen from the figure. The lower articulating face extends entirely across the brachials, and is furrowed as stated above in describing the radials.

Azygous Plates—Of these but the lower two are shown, and they have the arrangement of the corresponding plates in typical *Poteriocrinus*.

Arms—Of these there are ten at the top of the brachials. They divide again on the seventh and eighth plates above these (this num-

ber differing in different arms), and again on the eighth and ninth above these in most of the rays, the precise number of arms so dividing not being well shown. Each of these bifurcating plates, like the brachials, bears a spine which points outward and upward. Many of the intermediate plates bear spines much more delicate and inconspicuous. All the arm plates are cuneiform and either spinous or tuberculate.

Pinnulæ—These were composed of short, comparatively heavy joints, deeply excavated by the ambulacral groove.

Ventral Sac—Balloon shaped, and extending nearly to the tips of the arms. It is quite different from that of typical *Poteriocrinus*, and indicates, according to Mr Wachsmuth, "a link toward *Coeliocrinus*."

Column—Small, round, formed of alternately larger and smaller pieces, giving it much the appearance of that of *Glyptocrinus*. Canal, round.

Locality and Position—Pulaski county, Kentucky, Kaskaskia (Chester) Group. Sub-carboniferous.

Remarks—This species is rare, but three specimens having been found. It is readily referred to *Scaphiocrinus*, as defined by Wachsmuth and Springer, except by the form of the ventral sac. It seems not impossible that this organ will be found to possess much higher systemic value than has hitherto been given it.

Poteriocrinus anomalos, n. sp.

(Fig. 6, azygous side; 6*a*, symmetrical side; 6*b*, basal view, all three diameters.)

Under basals—Not present, or concealed by the column. It is most probable that the latter is the case.

Basals—Five, four pentagonal, about as wide as high, pointed above, with the exterior surface convex, somewhat more tumid in the central part. The fifth basal, being that on the azygous side, is heptagonal, enormously developed, being much wider and higher than either of the others, and extending in the latter direction, as may be seen in the figure, nearly to the top of the radial series, two plates of which it widely separates on this side. I have seen no case of this kind in any other species of crinoid that has fallen under my observation, and it may be a good generic character.

Radials—Five, three pentagonal, alike in shape and size, wider than high, pointed below, truncated above, the articulating surface being straight and extending entirely across the upper face of the plates. The two adjacent to the azygous side have the truncated lower side

resting upon one of the sloping faces of the contiguous basals, and the inner upper angle truncated, where it meets the suture, uniting the large basal with the two smaller azygous plates, supported by its upper surface. Though pentagonal, they are very different in shape from the other three. All these plates are very much thickened, so that the central portions are much elevated above the sutures, which gives the basal view a pentalobate appearance.

Brachials—Ten, first series five, quadrangular, equal in shape and size, wider than high, deeply constricted centrally, squarely truncated above and below, rapidly tapering upward, so that while the lower articulating face is equal to that of the radial, the upper is much shorter.

These plates are much thickened and tumid below. The suture uniting them with the radials gapes widely, leaving an exposed portion of the upper surface of the radial as in *Cromyocrinus* and *Eupachycrinus*. Second series, four pentagonal, higher than wide, centrally constricted, rapidly tapering upward, and giving rise to two arms upon the upper, sloping, outer side. These plates are likewise much thickened at the articulating extremities, and resemble, in that respect, and the central constriction, the brachials of the first series. The fifth plate of this series, or that opposite the azygous side, is quadrangular, being rendered so by the single articulating surface above, giving rise to a single arm instead of two. Its form is otherwise like that of the others.

Azygous Plates—Of these but three are well shown, the two lower being irregularly pentagonal, and resting upon the upper face of the large basal as before mentioned. Above these are two or three others, of which only the lower one is exhibited with any degree of distinctness

Arms—Nine, composed of plates shaped much like the upper brachials, longer than wide, quadrangular in shape, laterally constricted, with straight sutures. As the plates are long, and the arms comparatively short, the number of arm plates is unusually small. So far as can be determined the arms are without divisions.

Pinnulæ—These were few, but composed of stout and long pieces like those of the arms.

Ventral Sac—This was comparatively large, composed of heavy hexagonal plates, which are thickened and raised into more or less angular ridges at the sutures. This organ extended nearly to the extremity of the arms.

Column—Pentagonal, very small, the plates being alternately thicker and thinner, and ornamented at the angles with small tubercles or prominences. Canal, round and very small.

Locality and Position—Pulaski county, Kentucky, from the Kaskaskia (Chester) Group. Sub-carboniferous. Three specimens.

Remarks—This beautiful and curious species has been referred to *Cromyocrinus*, not without great hesitation. Among the divisions of *Poteriocrinus* established by Wachsmuth and Springer, their *Decadocrinus* most nearly embraces the characters of this species. But the description reads, "arms always ten." It differs from typical *Poteriocrinus* in the arrangement of the azygous plates, in the great thickening of the radials and brachials, the few joints of the arms, and the enormous development of the basal on the azygous side. All these features ally it to *Cromyocrinus* or *Eupachycrinus*, from which it differs in the greatly developed ventral sac, the few arm joints, and the comparatively short arms.

Mr. Wachsmuth, to whom I sent the species, after writing as follows: "This is one of those perplexing types which occur at the end of the sub-carboniferous, in which the characters shade from one genus to another by transition forms," refers it with some hesitation to *Poteriocrinus*.

In this reference he has the confirmatory evidence stated above. To my mind, however, the weight of evidence is in favor of a reference to *Cromyocrinus*, Trautschold, which Mr. Wachsmuth regards as a synonym of *Eupachycrinus*. The surface of this species to the second radial series is ornamented with numerous irregularly disposed tubercles; above this the second radials and arm plates are ornamented with slightly raised longitudinal ridges.

This crinoid has a very high interest, as one of those types to which attention was first called by Mr. Wachsmuth, embracing "transition characters," and occurring at the end of a long series of differentiations.

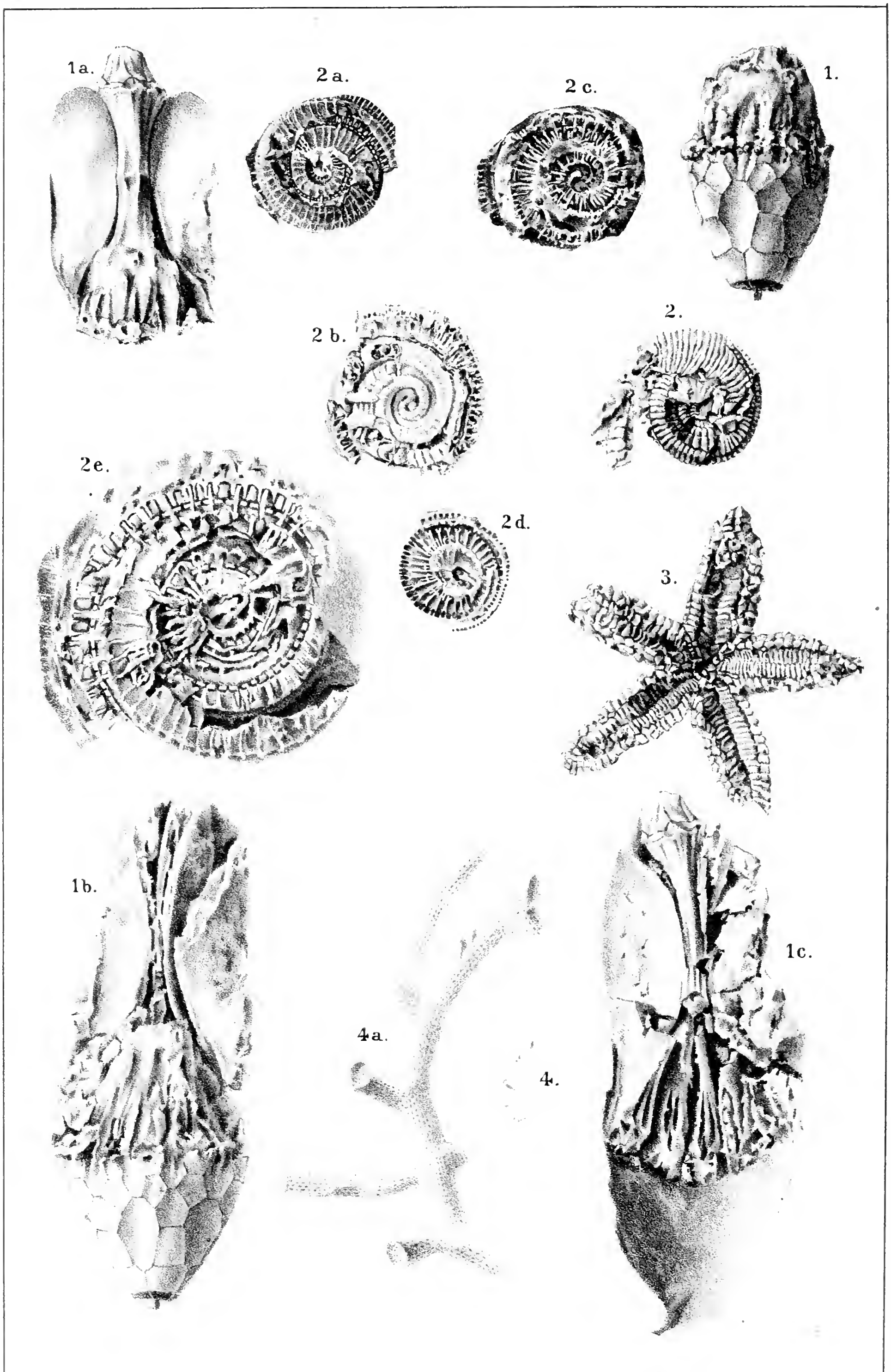

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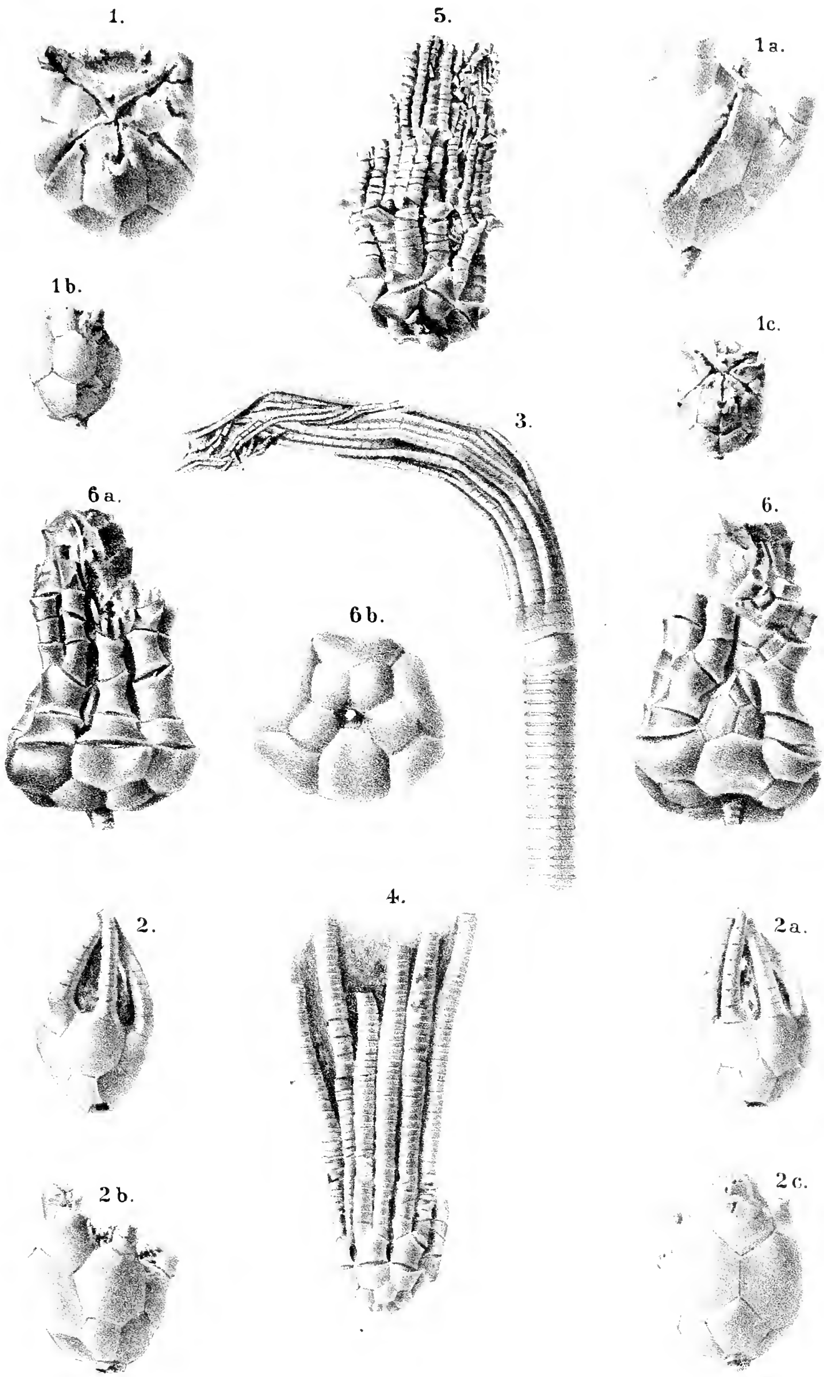
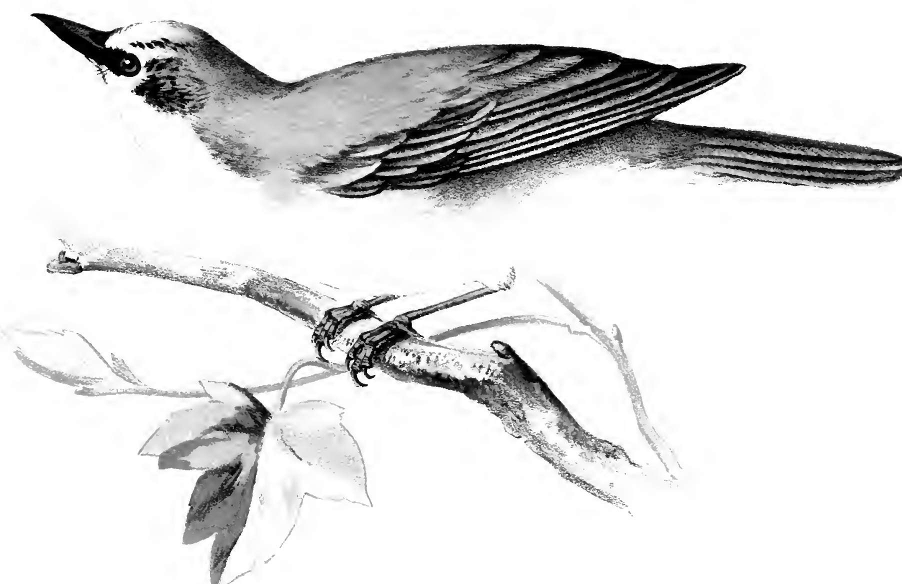
PLATE IV.

PLATE V.



KREBS LITHOGRAPHING COMPANY, CINCINNATI.

TIP OF TONGUE MAGNIFIED
ABOUT 25 DIAMETERS.



— Cincinnati Warbler. —

HELMINTHOPHAGA CINCINNATIENSIS. — LANGDON.

THE JOURNAL

OF THE

CINCINNATI SOCIETY OF NATURAL HISTORY.

VOL. III. CINCINNATI, OCTOBER, 1880. No. 3.

PROCEEDINGS OF THE SOCIETY.

TUESDAY EVENING, *July* 6, 1880.

Dr. R. M. Byrnes, President, in the chair. Present, 21 members.

Dr. Reuben A. Vance was elected a member of the Society.

Dr. A. J. Howe, Prof. G. W. Harper and Dr. D. S. Young were appointed a committee to report upon the feasibility of adding an aquarium to the Museum.

Prof. Ormond Stone, Dr. A. J. Howe and Dr. A. E. Heighway were appointed a committee to take such steps as may be necessary for extending an invitation to the American Association for the Advancement of Science, to hold its regular annual meeting, for the year 1881, in this city.

Donations were received as follows:

From W. C. Egan, of Chicago, Ill., specimens of *Myelodactylus bridgeportensis* and *Eucalyptocrinus* (*Hypanthocrinus*) *egani*, from the Niagara Group at Bridgeport, Ill., both of which were described in the July number of this Journal.

From Prof. Wm. L. Dudley, of the Miami Medical College, a collection of minerals and fossils, consisting of a thousand or more specimens.

From Dr. S. Saltmarsh, a bust (in plaster) of Charles H. Olmstead, formerly President of the Connecticut Society of Natural History. This present was very desirable and highly appreciated by the members of the Society.

From Master S. R. Miles, a specimen of lead ore from Columbus, Kansas; and from Dr. F. W. Langdon, some eggs of reptiles.

TUESDAY EVENING, *August* 3, 1880.

Dr. R. M. Byrnes, President, in the chair. Present, 16 members.

A. E. Heighway, Jr., was elected a member of the Society.

Mr. Davis L. James resigned his position as Curator of Botany for want of time to attend to the duties of the position. On motion, the election of a Curator to fill the vacancy was postponed until the next meeting of the Society.

The committee appointed at the last meeting for the purpose of extending an invitation to the American Association for the Advancement of Science, to hold its next annual meeting in this city, was directed to confer with the Chamber of Commerce, the city authorities and other public bodies, and also with the educational institutions of the city, for the purpose of making the invitation general, and was further directed to represent to the committee having the selection of the place for the meeting of the American Association for the Advancement of Science in 1881, that the necessary halls and rooms for the accommodation of the Association would be provided without any expense to the Association.

Donations were received as follows:

From Dr. A. E. Heighway, a human skull, showing the marks of an iron tomahawk, and supposed to be that of a white man killed by Indians; the skull was found in Licking county, Ohio; the Doctor also donated the skull of a Hindoo.

From A. E. Heighway, Jr., fine specimens of galena and of staurolite crystals, from North Carolina.

From M. F. Dougherty, three specimens of silver ore.

From Rev. J. G. Schall, a curious spider from the Camp-meeting ground, near Loveland, Ohio.

From J. G. O'Connell, a specimen of the garter snake (*Eulænia sistalis*).

From F. W. Langdon, specimens of *Planorbis trivolvus*, from Sandusky Bay, Ohio.

From Prof. John Collett, the First Annual Report of the Bureau of Statistics and Geology of Indiana.

TUESDAY EVENING, *September* 7, 1880.

Dr. R. M. Byrnes, President, in the chair. Present, 18 members.

The committee appointed to extend an invitation to the American Association for the Advancement of Science, to hold its next annual meeting in this city, reported that the invitation had been accepted with singular unanimity, and that the Association would hold its meeting here, commencing August 17, 1881. On motion, the committee were discharged. Dr. A. E. Heighway and Prof. Stone entertained the Society with a description of the reception and entertainment the Association received at Boston this year. It was a magnificent meeting, and the members were welcomed, entertained and feasted from the opening until the close of the session. The speakers were enthusiastic and so delighted with the good things received that they felt almost too full for utterance.

On motion a committee of three was appointed to confer with the various scientific and public bodies of the city, and with prominent citizens with the view to the organization of a general local committee, to make arrangements for the entertainment of the American Association for the Advancement of Science, during the meeting to be held here in August of next year. The chair appointed Prof. Stone, Dr. A. E. Heighway and Dr. Howe as the committee. It is not the intention that the Society shall do more than to take part in the entertainment of the Association. The reception and entertainment will be by all the public bodies of the city, as it will be an event in which all citizens will be interested, and in which our reputation for hospitality, refinement and education, will be exposed to the judgment of a competent board of examiners.

Mr. C. G. Lloyd was elected Curator of Botany to fill the vacancy occasioned by the resignation of Davis L. James.

Prof. G. W. Harper exhibited a large specimen of copper with veins of silver that he found in an excavation near Newcastle, Indiana. The specimen is about half an inch thick, about nine inches long, about three inches wide at one end and about an inch wider at the other end. (The writer did not measure the specimen and is stating the size from appearance only.) It had been pounded to this shape before burial, and as the thickness is uniform, it is evident that no attempt had ever been made to finish it. We may suppose that the Indian or the Mound Builder, as the case may have been, who owned it, understood the art of drawing out the copper uniformly, before beating one end of it to an edge. The specimen is large enough to have made a formidable weapon or a serviceable implement.

Donations were announced as follows: From Hon. Job. E. Stevenson, twenty-one different minerals from Mt. Vesuvius, which he collected on the Mountain during an expedition in the spring of 1879, viz: Lava rigato, Granito, Malachite, Meionite, Sodalite, Peridoto, Anfigena, Idrodolomite, Zolfo, Zolfo 1872, Lava 1879, Mica a foglio, Idocrasia, Idocrasia bruciato, Idocrasia con mica, Nepheline, Melanite, Ferro olivastro, Ilvaite, and Ilvaite con spinella; from Jos. Savage, two specimens of spider cases; from H. W. Stevenson, a large hornet; from Dr. F. W. Langdon, eggs in sets of the Florida Gallinule, American Coot, Black Tern and Long-billed Marsh Wren; from J. E. Frey, the head of a sea sturgeon, a very fine specimen, which is being mounted by our excellent artist and taxidermist, Mr. J. W. Shorten; from Mr. C. F. Low, a copy of the Annual Report of the Geological Survey of New York for the year 1838.

And from Dr. C. L. Metz, of Madisonville, a fine specimen of the paddle fish (*Polyodon folium*) from the Little Miami river. The taxidermy on this specimen is unsurpassed. It is the work of Mr. J. W. Shorten, and was by him donated to the Society.

PROCEEDINGS OF THE EXECUTIVE BOARD.

The Executive Board has held regular monthly meetings during the summer, and transacted the current business of the Society. Five hundred dollars has been appropriated for the purchase of books for the Library, most of which has been expended for that purpose. The committee having in charge the purchase of the books consists of C. F. Low, S. A. Miller and Dr. A. J. Howe. Fifteen hundred dollars has been appropriated for the purpose of increasing the palæontological collection of the Society. The committee having in charge the expenditure of this appropriation consists of Dr. J. F. Judge, Prof. J. Mickleborough, S. A. Miller, Prof. G. W. Harper and Prof. J. W. Hall, Jr. The Custodian, Dr. J. H. Hunt, has been authorized to cause to be provided the necessary cases and boxes for taking care of and displaying the palæontological collection.

CORRECTION.—A mistake occurs on page 15 of the April No. of the JOURNAL, Vol. iii., No. 1, in the article on the Cretaceous rocks by S. A. Miller, Esq. The words "now *Thoracosaurus neocæsariensis*," in the 14th line from the top of the page, should follow *Crocodilus clavirostris*, in the 12th line from the top of the page. *Dorudon serratus* is an Eocene species.

NORTH AMERICAN MESOZOIC AND CÆNOZOIC GEOLOGY AND PALÆONTOLOGY.

By S. A. Miller, Esq.

[*Continued from Vol. 3, page 118.*]

Recurring to the Rocks at Coalville, he says: As I have, however, mentioned faults and lateral displacements of the strata here, it may be thought, by some, who are yet incredulous in regard to the Cretaceous age of these coals, that these disturbances of the strata may have given origin to erroneous conclusions respecting the position of the beds containing the Cretaceous types with relation to the coals. This, however, is simply impossible, because these fossils occur both above and below the coal-beds, even in local exposures, where all the strata, and included coal-beds can be clearly seen conformable and in their natural positions with relation to each other. We found both above and below the main coal-bed, *Inoceramus problematius*, a widely distributed species, that is very characteristic of the Niobrara and Benton Groups of the Upper Missouri, which there occupy positions below the middle of the series. Again, far above this, numerous specimens of a larger *Inoceramus*, which, if not really identical with one of these forms, is scarcely distinguishable from *I. sagensis* and *I. nebrascensis*, which occur in the later members of the Upper Missouri series. From these facts, it is more probable that we have here, at and near Coalville, representatives of the whole Upper Missouri series, with possibly even lower members, farther up Weber river, than any of the known Upper Missouri subdivisions of the Cretaceous. If this is so—and there seems to be but little reason to doubt it—the marked difference observed between almost the whole group of fossils found here, and those of the Upper Missouri Cretaceous, would seem to indicate, that there was no *direct* communication between the Cretaceous seas or gulfs of that region and those in which these Utah beds were deposited. Differences of physical conditions, however, probably also played an important part in the production of this diversity of life, since it is evident from the great predominance of clays and other fine materials in the Cretaceous beds of the Upper Missouri, that they were deposited in comparatively deeper and more quiet waters than those in Utah, in which coarse sandstones, with occasional pebbly beds, predominate.

The strata including the beds of coal exposed on Sulphur creek,

near Bear river, in Western Wyoming, he regarded as of the same age as the Coalville series. His section here is 3,542 feet thick. The lower 1,213 feet he regarded as certainly Cretaceous, the next 2,049 feet he thought is probably Cretaceous, and the upper 280 feet he regarded as of Tertiary age.

The Bitter creek series, which is found along Bitter creek (a small tributary of Green river, in Wyoming), from Black Butte northwestward to Salt Wells Station, on the Union Pacific Railroad, and at Rock Spring, and some other points west of Salt Wells, consisting of a vast succession of rather soft, light-yellowish, lead-grey, and whitish sandstones, with seams and beds of various colored clays, shale, and good coal, the whole attaining an aggregate thickness of more than 4,000 feet, present a mingling of fresh, brackish, and salt water types of invertebrate fossils, such as *Goniobasis*, *Viviparus*, *Corbicula*, *Corbula*, *Ostrea*, *Anomia*, and *Modiola*. This is the Lignitic Group which Prof. Lesquereux determined from the character of the plants to be of Eocene age, and Prof. Cope, from the Dinosaurian remains, to be of Cretaceous age. Prof. Meek thought the Judith river brackish-water beds are of the same age, and that the invertebrate fossils alone left the question of the age of the series in doubt. He stated the information as to its age in the following summary:

1. That it is conformable to an extensive fresh-water Tertiary formation above, from which it does not differ materially in lithological characters, excepting in containing numerous beds and seams of coal.

2. That it seems also to be conformable to a somewhat differently composed group of strata (1,000 feet or possibly much more in thickness) below, apparently containing little if any coal, and believed to be of Cretaceous age.

3. That it shows no essential difference of lithological characters from the Cretaceous coal-bearing rocks at Bear river and Coalville.

4. That its entire group of vegetable remains (as determined by Prof. Lesquereux) presents exclusively and decidedly Tertiary affinities, excepting one peculiar marine plant (*Halymenites*), which also occurs thousands of feet beneath undoubted Cretaceous fossils, at Coalville, Utah.

5. That all of its animal remains, yet known, are specifically different from any of those hitherto found in any of the other formations of this region, or, with perhaps two, or possibly three exceptions, elsewhere.

6. That all of its known invertebrate remains are mollusks, consisting of about thirteen species and varieties of marine, brackish and

fresh water types, none of which belong to genera peculiar to the Cretaceous or any older rocks, but all to such as are alike common to the Cretaceous, Tertiary and present epochs, with possibly the exception of *Goniobasis*, which is not yet certainly known from the Cretaceous.

7. That, on the one hand, two or three of its species belong to sections or subgenera (*Leptesthes* and *Veloritina*) apparently characteristic of the Eocene Tertiary of Europe, and are even very closely allied to species of that age found in the Paris basin; while, on the other hand, one species seems to be conspecific with, and two congeneric with (and closely related specifically to) forms found in brackish-water beds on the Upper Missouri, containing vertebrate remains most nearly allied to types hitherto deemed characteristic of the Cretaceous.

8. That one species of *Anomia* found in it is very similar to a Texas Cretaceous shell, and perhaps specifically identical with it; while a *Viviparus*, found in one of the upper beds, is almost certainly identical with the *V. trochiformis* of the fresh-water lignite formation of the Upper Missouri; a formation that has always, and by all authorities, been considered Tertiary.

9. That the only vertebrate remains yet found in it are those of a large reptilian (occurring in direct association with the *Viviparus* mentioned above) which, according to Prof. Cope, is a decidedly Cretaceous type, being, as he states, a huge Dinosaurian.

He described from Coalville, Utah, *Ostrea soleniscus*, *Avicula propleura*, *A. gastrodes*, *Modiola multilinigera*, now *Volsella multilinigera*, *Cyrena carletoni*, *Neritina bellatula*, *N. patelliformis*, *N. carditoides*, *N. bannisteri*, *N. pisum*, *N. pisiformis*, *Admete rhomboides*, *A. subfusiformis*, *Turritella coalvillensis*, *T. micronema*, *T. spironema*, *Fusus gabbi*, *F. utahensis*, *Turbonilla coalvillensis*, *Eulima chrysalis*, *E. inconspicua*, *Melampus antiquus*, *Valvata nana*, *Physa carletoni*; from the Missouri river below Gallatin City, Montana, *Ostrea anomioides*, *Corbicula inflexa*, *Pharella pealei*; from Bear river city, on Sulphur creek, Wyoming, *Trapezium micronema*, *Corbicula æquilateralis*, *C. securis*, from near Cedar City, Southern Utah, *Corbula nematophora*; from the Bitter creek series, at Point of Rocks, Wyoming, *Ostrea wyomingensis*, *Corbula tropidophora*; from Black Butte Station, *Corbicula bannisteri*, *Melania wyomingensis*; and from Rock Spring Station, Central Pacific Railroad, Wyoming, *Corbula undifera* and *Goniobasis insculpta*.

Prof. E. D. Cope* described, from Solomon river, Kansas, *Portheus gladius*, now *Pelecopterus gladius*, and *Portheus lestrio*.

Prof. O. C. Marsh† described, from Kansas, *Apatornis celer*.

Dr. Joseph Leidy‡ described, from Smoky Hill river, Kansas, *Clidastes affinis;* and from Columbus, Mississippi, *Eumylodus laqueatus*.

Mr. James Richardson§ separated the Cretaceous rocks of Vancouver Island into seven divisions in ascending order as follows:

A. Productive coal measures.

B. Lower shales.

C. Lower conglomerate.

D. Middle shales.

E. Middle conglomerate.

F. Upper shales.

G. Upper conglomerate.

A section of division A., on Brown's river, is shown to be 739½ feet thick. Division B., on Sable river and Denman Island, 1,000 feet. Division C., on Denman and Hornby Islands, between 900 and 1,000 feet. Division D, on Hornby Island, 70 feet. Division E., on Hornby Island, from 1,100 to 1,200 feet. Division F., near Tribune Bay, 776½ feet. And Division G., on Tribune Bay, 320 feet. Making a total thickness of 5,000 feet.

Dr. Dawson‖ described, from the Lower Cretaceous of Queen Charlotte Islands, *Cycadeocarpus columbianus*.

In 1874, Dr. F. V. Hayden¶ said, that to one who has carefully studied the divisions along the Missouri river, the Cretaceous beds in Colorado and New Mexico, may be separated into five groups, without much difficulty. The Dakota group is well shown and is always characteristic, though seldom containing any organic remains. The Niobrara group is represented by a thin bed of impure gray limestone, and thin calcareous shale, with *Ostrea congesta* and a species of *Inoceramus*. The fossils are about the same as those occurring on the Missouri, but the rocks have little of the chalky texture, as observed in the northwest and in Kansas. The Fort Benton and Fort Pierre groups are black shaly clays, and do not differ materially from the same groups occurr-

* Proc. Acad. Nat. Sci.

† Am. Jour. Sci. and Arts, 3d series, vol. 5.

‡ Cont. to Extinct Vert. Fauna. W. Terr.

§ Geo. Sur. Can.

‖ Geo. Sur. Can.

¶ Ann. Rep. U. S. Geo. Sur. Terr.

ing in other localities to the northward. The Fox Hills group contains a great abundance of well marked Cretaceous fossils, many of the species identical with those found on the Missouri river. This group passes up into the lignite strata, apparently, without any marked unconformability. In passing upward in the Fox Hills Group, one by one the mollusca of purely marine character disappear until only some varieties of oysters remain, with the plants peculiar to the Lignitic Group.

The relation of the well-defined Cretaceous with the Lignitic Group forms one of the most important problems in Western geology, and the area for the solution of the question probably lies in the Laramie plains and westward toward Salt Lake, where the aggregate thickness is from 10,000 to 20,000 feet. So far, the evidence from the vegetable remains is wholly in favor of the Tertiary age of the coal group. The vertebrate remains, according to Prof. Cope, place the coal group with the Cretaceous, while the proof from the invertebrate fossils is not strong in any direction, although, perhaps, leaning toward the Tertiary. We must admit, however, that the lower coal-beds are of Cretaceous age so far as the evidence goes. For instance, the Coalville and Bear river beds are most probably Cretaceous, inasmuch as many undoubted Cretaceous types are found in strata above the coal, and further south, in New Mexico, Arizona, and Utah, there are coal-beds of undoubted Cretaceous age.

A. R. Marvine* described the Dakota Group between the Big Thompson and South Platte. It can be traced from one point to the other, though it is somewhat obscured near Golden City ; this is due to the fact, that its hardness is greater than the beds either above or below, and it forms a more persistent hog-back ridge than any other group. Between the cross-cutting streams for all this distance and beyond, it rises in its long characteristic ridge, capping the soft Jurassic beds below, and whether the dip be high or low, usually reaching to about the same level. The sandstones are usually clean, gritty, even-grained and silicious in texture, varying from a silicious conglomerate, on the one hand, to a hard quartzite on the other, and only occasionally becoming soft. Their color is usually light yellow or light gray, or even white, varying to rusty yellow, and only occasionally red in the softer portions. These are the hard and massive portions which characterize the group, and which are separated by thin, shaly layers, which may be quite argillaceous or even carbonaceous in character, with many broken remains of fossil plants. A section at Bear Canon

* Hayden's U. S. Geo. Sur. Terr.

shows a thickness of 240 feet, and another near the South Platte river, 385 feet.

The Fort Benton Group consists of a series of shaly beds, which may be either highly argillaceous or quite arenaceous in character, there being associated with them, in either case, a few thin, brown sandstones; the thickness from Big Thompson to South Platte varying from 100 to 400 feet. A section at Little Thompson creek shows a thickness of 400 feet, and one at Bear Canon 120 feet.

The Niobrara Group is decidedly calcareous, and usually contains numerous fossils. A section at Bear Canon shows 105 feet, and one at Little Thompson creek 150 feet. The Fort Pierre Group, at Bear creek is about 300 feet in thickness.

The total thickness of the Dakota, Fort Benton, Niobrara, Fort Pierre, and Fox Hills Group, at the Middle Park, is estimated at from 3,500 to 4,500 feet. A section of the Lignitic Group at Golden City shows a thickness of 3,360 feet, and the estimated thickness at Middle Park is 5,500 feet.

Prof. Leo Lesquereux* described, from the Lignitic Group at Golden, Colorado, *Woodwardia latiloba*, *Pteris erosa*, *P. subsimplex*, *P. affinis*, now *Osmunda affinis*, *Aspidium goldianum*, now *Lastrea goldana*, *Sphenopteris membranacea*, *Selaginella berthoudi*, *Hymenophyllum confusum*, *Flabellaria fructifera*, now *Sabalites fructiferus*, *Quercus goldanus*, *Ficus planicostata*, var. *goldana*, *F. zizyphoides*, *Platanus rhomboidea*, *Vibernum lakesi*, *Nelumbium lakesanum*, *Zizyphus distortus*, *Rhamnus inæqualis*; from Black Butte, Wyoming, *Woodwardia latiloba*, var. *minor*, *Sphenopteris nigricans*, *Quercus cleburni*, *Pisonia racemosa*; from the roof of coal mines at Sand creek, Colorado, *Pteris gardneri*, now *Gymnogramma gardneri*, *Equisetum lævigatum*, *Eriocaulon porosum*, *Nelumbium tenuifolium*; from Coal creek, Colorado, *Cornus holmesi*; from Evanston, *Laurus sessiliflora*, now *Tetranthera sessiliflora*; and from Mount Brosse, or Troublesome creek, *Persea brossana*, now *Laurus brossana*, and *Cornus impressa*.

Prof. E. D. Cope, from the evidence of the vertebrates, and especially from the evidence afforded by the remains of the *Dinosauria*, referred the Fort Union or Lignitic Group, the Judith River Group, the Bitter Creek Group, and the Bear River Group to the upper Cretaceous. And he described, from the Fort Union Cretaceous, of Colorado, *Cionodon arctatus*, *Polyonax mortuarius*, *Bottosaurus perrugosus*, *Trionyx vagans*, *Plastomenus punctulatus*, *P. insignis*, and *Adocus lineolatus*.

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* Hayden's 7th Rep. U. S. Geo. Sur. Terr.

T. A. Conrad described, from Trout creek, near Fairplay, *Ptychoceras aratum* and *Meekia bullata;* from seven miles south-southeast of Fairplay, *Helicoceras vespertinum*, *Anchura bella ;* and from near Denver, *Haploscapha capax.*

Prof. Leo Lesquereux * described, from the Dakota Group at Fort Harker, Kansas, *Lygodium trichomanoides*, *Greviopsis haydeni ;* from Kansas, *Todea saportanea*, *Dioscorea cretacea*, *Flabellaria minima*, *Alnus kansasana*, now *Hamamelites kansasanus*, *Myrica obtusa*, *Quercus poranoides*, *Sassafras acutilobum*, *Oreodaphne cretacea*, *Embothrium daphneoides*, *Diospyros rotundifolia*; from Minnesota, *Ficus hallana;* from Decatur, Nebraska, *Hedera ovalis*, *Protophyllum nebrascense;* from the bluffs of Salina River, *Protophyllun minum;* from Warner's quarry eight miles from Winnebago village, bluffs of the Missouri river, *Ptenostrobus nebrascensis.*

The Cretaceous is visible, in North Carolina,† only in the bluffs in the southeastern part of the State, from the Neuse and its tributary Contentnea, southward. It is best exposed, in the bluffs, along the Cape Fear between Fayetteville and Wilmington. The rocks for 50 to 60 miles below Fayetteville consist of sandstones, clay slates and shales, 30 to 40 feet thick, in many places dark to black and very lignitic, with projecting trunks and limbs of trees, and at a few points full of marine shells. For 40 to 50 miles above Wilmington, and in all the other river sections, the rock is a uniform, dark, greenish-gray, slightly argillaceous sandstone, massive, and showing scarcely any marks of bedding. This sandstone everywhere contains a small percentage of glauconite, and is the representative of the true greensand.

The Ripley Group was so named by Conrad from the town of Ripley, Mississippi,‡ in 1858, and some of the species of shells at that place are identical with species from North Carolina, Georgia, Eufaula, Alabama, and Haddonfield, New Jersey. The mineral character of the beds and state of preservation of the fossils are the same, proving not only a simultaneous deposit, but a similar depth of water, not in an estuary but in a marine basin. This group constitutes the great bulk of the Cretaceous strata east of the Mississippi, and, as Conrad supposed, corresponds most nearly in age with the Senonian stage of D'Orbigny, or that part of the Cretaceous which underlies and most nearly approaches in age the chalk.

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* Cret. Flora, Hayden's U. S. Geo. Sur. Terr., vol. 6.
† Geo. of N. Carolina, 1875.
‡ Jour. Acad. Nat. Sci. 2d Ser. vol. 3,

In 1875, he described,* from the Ripley Group at Snow Hill, Greene county, North Carolina, *Anomia linifera*, *Radula oxypleura*, *Trigonarca triquetra*, *T. umbonata*, *T. perovalis*, *T. carolinensis*, *T. congesta*, *Nemodon brevifrons*, *Barbatia carolinensis*, *B. lintea*, *Arcoperna carolinensis*, *Inoperna carolinensis*, *Mytilus condecoratus*, *M. nasutus*, *Etea carolinensis*, *Brachymeris alta*, *Crassatella carolinensis*, *C. pteropsis*, *Arene carolinensis*, *Lucina glebula*, *Cardium carolinense*, *Protocardia carolinensis*, *Aphrodina regia*, *Cyclothyris alta*, *C. carolinensis*. *Baroda carolinensis*, *Oene plana*, *Linearia carolinensis*, *Valeda lintea*, *Cyprimeria depressa*, *Hercodon ellipticus*, *Cymella bella*, *Corbula carolinensis*, *C. bisulcata*, *C. perbrevis*, *C. subgibbosa*, *Diploconcha cretacea*, *Callonema carolinense*, *Leioderma thoracica*, *Lunatia carolinensis*, and from Cape Fear river, *Corbula oxynema*, and *Anomia lintea*.

The Cretaceous rocks,† corresponding in age with the great chalk formations of Europe, though very different from them in mineral character, are spread over a great extent of surface in the western part of British America. Except in a few localities, and those chiefly in proximity to the Rocky Mountain region of uplift, they are still almost as perfectly horizontal as when first deposited. The eastern edge overlaps Silurian and Devonian beds, and runs nearly parallel with the base of the Laurentian range for a distance of about 130 miles, from the 53d to the 55th parallel of latitude. Southward it trends to the East, and probably crosses the 49th parallel east of Red river; while in southwestern Minnesota it reposes in some places directly on granites which are no doubt Laurentian. The general course of the eastern outcrop is consequently about north-northeast; and it is marked, broadly, by a series of escarpments and elevations, including —from south to north—Pembina, Duck, Porcupine and Basquia Mountains. All these appear to be composed, for the most part, if not entirely, of Cretaceous rocks, though the extreme edge of the formation may often stretch beyond them. These mountains are, more correctly speaking, the salient points of the edge of the second plateau, and the generally horizontal position of the beds thus suddenly cut off to the east, attests the immense denudation which must have taken place in modern times. North of the Basquia Mountain the edge of the Cretaceous would appear to run westward and cross the Saskatchewan near Fort a la Corne, where, at Cole's Falls, a dark-colored shale has been referred to the lowest member of the series. The

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* Geo. of N. Carolina, 1875.
† Dawson's Rep. Geo., 49th Parallel, 1875.

western border of the Cretaceous seems, in some places, to follow closely along the base of the Rocky Mountains, but many circumstances arise to complicate it in that region.

The Lignitic Group north of the 49th parallel is not bounded by any great physical features of the country, but adheres closely to the upper members of the Cretaceous. Though, no doubt, originally deposited in extensive basin-like depressions, it is now generally found forming slightly elevated plateaus. Denudation must have acted on these rocks on a vast scale, but they still cover an immense area, and contain the greatest stores of mineral fuel known to occur in the vicinity of the 49th parallel. The line of their eastern edge crosses the parallel near the 102d meridian, and thence appears to pursue a north-westward course, remaining for some distance nearly parallel with the edge of the third plateau. Beyond the elbow of the South Saskatchewan, though the same physical feature continues to the north, it is not known what relation it may bear to the outcrop of this formation, nor has its northern limit been ascertained.

On leaving the Lake of the Woods, and proceeding westward, the face of the country is found to be thickly covered with drift and alluvial deposits. The Silurian limestones, which probably exist at no very great depth, are not observed, and the first rocks seen are those of the Cretaceous along the base of Pembina mountain, which bounds the Red river valley on the west. From this point westward to the base of the Rocky Mountains no rocks are found older than the Cretaceous. About 25 miles north of the Line, where the Boyne river cuts through the Pembina escarpment the Niobrara Group is found exposed. The rock is a cream-colored or nearly white limestone, breaking easily along horizontal planes, parallel to the surfaces of the shells of *Ostrea congesta*, and *Inoceramus*, of which it is in great part composed. The rock also abounds with more or less perfect remains of Foraminifera, Coccoliths, and allied microscopic organisms. Prof. G. M. Dawson here proposes the name of Pembina Mountain Group for what he supposes may be the equivalent of the Fort Pierre Group. It is exposed in the valley, by which the Commission Trail ascends Pembina mountain, about ten miles north of the 49th parallel, and where the 49th parallel cuts the base of the Pembina escarpment rocks, and at various other places for about 40 miles west of the foot of Pembina mountain. In some places the exposures vary from 100 to 240 feet. From this point for 350 miles west no exposures of the Cretaceous occur on account of the drift deposits which cover the surface. When the rocks underlying the drift are again seen, near La Roche Percee, they belong to the Lignitic Group.

The Lignitic Group appears, in the valley of the Souris river, 250 miles west of Red river and affords numerous sections. The mollusca as well as the characters of the strata show that it is the equivalent of the Fort Union Group. A bed of lignite, 7 feet 3 inches in thickness, occurs in the Souris valley about a mile north of the position occupied by the Wood End depot. The strata appear to be nearly horizontal. West of Wood End, the Souris valley runs north-westward along the base of the Coteau, diverging rapidly from the boundary line. It loses, at the same time, its abrupt character, and no exposures of the rocks occur for a long distance. In following the 49th parallel, the escarpment of the third great prairie level is overcome, and it is not till after having passed through the broken Coteau belt, and reached the Great Valley, that exposures of the underlying rocks occur. This valley is the most eastern great channel of erosion which crosses the Line southward, toward the Missouri, and in it the beds of the Lignitic Group are exhibited on a grand scale. On the boundary-line, thus a space of 82 miles, from the 263 to the 345 mile point, is completely shrouded by drift. There is every reason to believe, however, that the Lignitic Group stretches uninterruptedly between the two localities, and an exposure some distance north of the line sustains this view.

In the Great Valley, the beds exposed are at an elevation of about 700 feet greater than those near Wood End, on the Souris river. They consist of shales, clays, and sandstones, with beds of lignite. The next stream crosses the line at the 351 mile point, called Pyramid creek, where the lignite beds are again exposed. They reappear on Porcupine creek, 35 miles farther west, and near the 393 mile point, on the line, an 18 feet bed of lignite occurs. The fossil plants here are nearly identical with those of the Fort Union Group. In the neighborhood of Wood Mountain, hard, grayish sandstones, belonging to this group, are exposed, in the sides of the hills and banks of the valleys. At 19 miles from Wood Mountain the edge of the plateau is reached, and a few miles further on, the junction of the lignite with the marine Cretaceous is crossed. Twenty miles south of the Wood Mountain settlement, on the 49th parallel, near the 425 mile point from Red river, the Lignitic Group is found superimposed upon the marine Cretaceous. The exposures are numerous, and are produced by the streams flowing from the southern escarpment of the water-shed plateau, which has been gashed by their action into most rugged *Bad Lands.*

This term has attached to it, in the western regions of America, a

peculiar significance, and is applied to the rugged and desolate country formed where the soft clayey formations are undergoing rapid waste. Steep irregular hills of clay, on which scarcely a trace of vegetation exists, are found, separated by deep, nearly perpendicular-sided, and often well nigh impassable valleys; or when denudation has advanced to a further stage—and especially when some more resisting stratum forms a natural base to the clayey beds—an arid flat, paved with the washed-down clays, almost as hard as stone when dry, is produced, and supports irregular cones and buttes of clay, the remnants of a former high-level plateau. Denudation, in these regions, proceeds with extreme rapidity during the short period of each year, in which the soil is saturated with water. The term, first and typically applied to the newer White river Tertiaries of Nebraska, has been extended to cover country of similar nature in the lignite regions of the Upper Missouri and other areas of the West. In the Bad Lands, south of Wood Mountain, the hills assume the form of broken plateaus; degenerating gradually into conical peaks, when a harder layer of sandstone, or material indurated by the combustion of lignite beds, forms a resistant capping. Where no such protection is afforded, rounded mud-lumps are produced from the homogeneous, arenaceous clays. Waste proceeds entirely by the power of falling rain, and the sliding down of the half-liquid clays, in the period of the melting snow in spring. The clay hills are consequently furrowed, from top to base, by innumerable runnels, converging into larger furrows below. The small streams, rapidly cutting back among these hills, have formed many narrow, steep-walled gullies, while the larger brooks have produced wide, flat-bottomed valleys at a lower level, in which the streams pursue a very serpentine course. Denudation is even here, however, still going on as from the frequent change in the channel of the stream, it is constantly encroaching on the banks of the main valley, undercutting them and causing landslips.

The general section at this place, in descending order, is as follows:

1. Yellowish sand and arenaceous clay, sometimes indurated in certain layers and forming a soft sandstone. It forms the flat plateau—like tops of the highest hills seen. About 50 feet.

2. Clays and arenaceous clays, with a general purplish-gray color when viewed from a distance. It contains a lignite-bearing zone and beds, rich in the remains of plants, and in the lower part, the remains of vertebrate animals. About 150 feet.

3. Yellowish and rusty sands, in some places approaching arenaceous clays, often nodular. About 80 feet.

4. Grayish-black clays, rather hard and very homogeneous, breaking into small angular fragments on weathering, and forming earthy banks. This division belongs to the upper part of the Fox Hills Group, and only about 40 feet of it is exposed at this place.

The sombre clays of the Fox Hills Group may be traced almost continuously for a distance of about ten miles west, on the 49th parallel, where lower beds are exposed. Near the crossing of the 49th parallel and trail to Fort N. J. Turney, where the Wood Mountain Astronomical Station was established, good exposures of the Fort Pierre Group occur in the banks of the valley of a large brook. Taking into consideration the difference of level between this locality and that of the section above, it appears that the Fort Pierre Group must be at least 200 feet below the Fort Union or Lignitic Group.

Westward from these sections the continuity of the Cretaceous clays in the vicinity of the boundary line is indicated by occasional small exposures, and at a distance of 13 miles a tolerably good exhibition of the Fort Pierre Group occurs. Where the boundary line crosses White Mud river, or Frenchman's creek, numerous and very fine exposures occur. The stream flows in the bottom of a great trough, cut out of the soft Cretaceous strata, over 300 feet deep, and in some places fully three miles wide. The tops of the banks, on both sides of the valley, are formed of yellowish ferruginous sands referable to the base of the Fort Union Group. Below this the sombre clays of the Fox Hills and Fort Pierre Groups have a thickness of 273 feet to the water level of the river. A similar section occurs on the main trail going west from Wood Mountain in the Valley of the White Mud river, 16 miles north of the 49th parallel, and 23 miles northwest of the last described exposure.

On the western side of White Mud river, hilly ground occurs, and at about the 505 mile point from Red river, the prairie makes a very definite rise and forms a plateau, which extends along the 49th parallel to the 534 mile point. The plateau is composed of the Fort Union Group. On coming to the western edge of this plateau, a great area of barren and arid prairie, at a lower level, and based on the Fort Pierre Group is seen stretching westward toward Milk river. An interesting section of the Fort Pierre Group and lower strata occurs, in a deep valley, about six miles west of the East Fork of Milk river, on and near the 49th parallel. The thickness exposed is 893 feet. The Valley of the Milk river offers continuous and magnificent sections of the Fort Union Group. The country, on both sides of it, is seamed with tributary ravines and gorges, the banks of which are often nearly

perpendicular, and which ramify in all directions. The banks of Milk river rise abruptly nearly 300 feet above the level of the stream, and are more than a mile apart. Sections of the Fort Union Group were obtained near the 49th parallel 284 feet in thickness. In the coulees and gorges which intersect the prairie on the west side of the Milk river, exposures of the same group continue to occur for many miles. Near the 620 mile point, west of Red river, a very interesting and highly fossiliferous section of the brackish water deposits of the Fort Union Group is exposed. In the valleys which seam the flanks of the hills, and furrow the surface of the prairie around East Butte numerous more or less extensive exposures of this group occur. But on the west side of West Butte, where a considerable brook issues from the central valley, a section of the Fort Pierre Group is exposed, 800 feet in thickness.

The exposures of the Fort Union Group continue to occur as we go west until the base of the Rocky Mountains is reached. They occur on the branches of Milk river, St. Mary river and the Belly river.

Prof. G. M. Dawson found the Lignitic or Fort Union Group everywhere conformable with the Fox Hills Group below. He referred it to Tertiary age, and estimated the thickness, assuming the horizontality of the beds and the rise in the general surface of the country, at not less than 1,000 feet.

Dr. J. W. Dawson* described, from the Fort Union Group, south of Woody Mountain, *Lemna scutata*, and from west of Woody Mountain, *Æsculus antiqua.*

Prof. E. D. Cope† described, from the Fort Union Group, six miles west of First Branch of Milk river, near latitude 49°, *Cionodon stenopsis*, *Compsemys ogmius*, and from the Bad Lands of South Woody Mountain, *Plastomenus coalescens*, and *P. costatus.*

Speaking of the age of the Fort Union or Lignitic Group, the Bitter creek series and the Bear River Group he says‡ that Prof. Lesquereux, as is well known, pronounced this whole series of formations to be of Tertiary age. The material (fossil plants) on which this determination is based is abundant, and it must be accepted as demonstrated beyond all doubt. But that he regarded the evidence derived from the mollusks in the lower beds and the vertebrates in the higher as equally conclusive that the beds are of Cretaceous

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* Rep. Geo., 49th parallel.
† Geo. Rep., 49th parallel.
‡ Vert. Cret. Form. of the West.—Hayden's U. S. Geo. Sur. Terr., vol. 2.

age. There is, then, no alternative but to accept the result that a Tertiary flora was contemporaneous with a Cretaceous fauna, establishing an uninterrupted succession of life across what is generally regarded as one of the greatest breaks in geologic time.

He described, from the Niobrara Group, of Colorado, *Syllæmus latifrons;* from the Fort Benton Group, two miles west of Sibley, Kansas, *Pelycorapis varius;* from the Niobrara Group or yellow chalk, near the Solomon river, Kansas, *Portheus arcuatus*, *P. mudgei*, and *Pachyrhizodus leptopsis;* from Ellis county, Kansas, *Lamna macrorhiza*, *L. mudgei*, and *Empo merrilli;* from Trego county, *Empo contracta* and *Empo semianceps;* from the neighborhood of Fort Wallace, *Phasganodus carinatus*, *P. gladiolus*, *P. anceps;* from Phillips county, *Tetheodus pephredo;* from Kansas, *Enchodus dolichus*, *E. petrosus*, *Pelecopterus chirurgus*, *Toxochelys serrifer;* from Stockton, Kansas, *Ptychodus janewayi;* from Spring creek, in Rooks county, *Pelecopterus perniciosus;* from the Greensand of New Jersey, *Osteopygis erosus*, *Enchodus oxytomus*, *E. tetraecus*, *Leptomylus forfex*, *Diphrissa latidens*, *Bryactinus amorphus*, *Ischyodus stenobryus*, *I. tripartitus*, *I. longirostris*, *I. incrassatus*, *I. gaskilli*, *I. fecundus*, *Isotænia neocæsariensis*.

And he furnished a section of the Cretaceous rocks of the region west of the Sierra Madre range of New Mexico as follows:*

Dakota Group, 500 feet.

Fort Benton Group, 2,000 feet.

Niobrara Group, 400 feet.

Fort Pierre Group, 1,500 feet.

Uncertain (concealed in the Sage plain), 500 feet.

G. K. Gilbert† found a section of the Cretaceous exposed by the north fork of the Virgin river, from the vicinity of Mountain Lakelet to Rockville, Southern Utah, 1,800 feet in thickness, and another on the west fork of Paria creek, 935 feet.

Prof. G. F. Credner‡ described, from the Cretaceous of Texas, *Salenia texana*.

J. J. Stephenson§ found the Cretaceous out-crop practically unbroken from Golden, Colorado, to Mexico. On the west side of the front or eastern range, there is a narrow area, of which only isolated portions remain in Huerfano, Wet mountain, Current creek, and South

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* Proc. Acad. Nat. Sci.
† Geo. Sur. W. 100th Meridian, vol. 3.
‡ Zeitschrift fur d. gesammten Naturwiss.
§ Geo. Sur. W. 100th Meridian, vol. 3.

Parks. In the area of the San Juan they are the only rocks exposed between Macomb's trail and the New Mexico line, excepting the small patch of Triassic, on the Rio Florida, and Rio de las Animas. The rocks differ in detail, but as a whole, the series is made up of three divisions. The lower is a mass of sandstone 200 to 500 feet thick; the middle is composed of shales and limestones, with, in the eastern localities, marls and sandstones 1,000 to 1,500 feet; and the upper, chiefly sandstones, with intercalated shales and lignites 500 to 700 feet.

He referred the whole lignite bearing series exposed at Canon City, and at other localities along the eastern base of the Rocky mountains, to the upper Cretaceous.

In 1876, Prof. J. W. Powell* separated the Cretaceous rocks of the Plateau Province of the west, in ascending order, as follows:

1. Henry's Fork Group, 500 feet.
2. Sulphur Creek Group, 2,050 feet.
3. Salt Wells Group, 2,000 feet.
4. Point of Rocks Group, 2,000 feet.

The Henry's Fork Group consists of sandstones, bad land rocks, conglomerates and shales, with carbonaceous shales and lignitic coal. It has an out-crop parallel and approximately co-extensive with the Triassic and Jurassic; that is, like those groups, it was brought up by the great Uinta upheaval, and the elevation of the Yampa Plateau. The conglomerates have a much more extensive development on the south than on the north side of the Uinta mountains. On the south side of the Yampa plateau, where the Fox creek and Cliff creek flexures unite, they stand on edge, with a dip of about 85° to the southeast, and are firmly cemented, and stand as high walls, separated by a long, narrow valley, strewn with fragments of the conglomerate which have tumbled down from either side.

The Sulphur Creek Group consists of black shales, occasionally friable sandstones with carbonaceous shales and lignitic coal. It is well exposed near Hilliard station, on the Union Pacific railroad, in the hills cut by Sulphur creek; there are many fine exposures on the north and south sides of the Uinta mountains; on Henry's Fork; between the head of Dry Lake valley and Vermilion creek; in the Escalante valley, Paria valley, Kanab valley, and many other localities.

The Salt Wells Group consists of sandstones or arenaceous shales; often very friable, producing bad lands, with carbonaceous shales and

* Geo. of Uinta Mountains.

lignitic coal. The rocks are well exposed on Green river, about two and a half miles above Flaming Gorge; along the northern flanks of the Uinta mountains; in the Pink cliffs; at Gunnison's Butte, on Green river south of Gray canon, but especially in the cliffs and escarped hills of the Salt Wells basin, east of the debouchure of the Point of Rocks canon.

The Point of Rocks Group consists of sandstones, usually indurated, sometimes ferruginous, with many beds of carbonaceous shales and lignitic coal, and is divided into the Golden Wall Sandstone, the Middle Hogback Sandstone, and the Upper Hogback Sandstone. The rocks are well exposed at Point of Rocks Station on the Union Pacific Railroad, in the escarpments facing Bitter Creek, at Rock Springs, on Green river, 2 miles above Flaming Gorge, at the foot of Desolation Canon, and Gray Canon on Green river, in the Wahsatch Cliffs at the head of the Escalante river, and in the hills at the foot of the Pink Cliffs in Southern Utah.

Prof. C. A. White* described, from the Point of Rocks Group, near Point of Rocks, Wyoming, *Ostrea insecura*, *Odontobasis buccinoidea;* from Upper Kanab, Utah, *Unio gonionotus*, *Planorbis kanabensis*, *Physa kanabensis*, *Helix kanabensis;* and from Bear River Valley, near Mellis Station, Wyoming, *Rhytophorus meeki*, *Goniobasis cleburni*, *G. chrysaloidea*, *Viviparus panguitchensis;* from the Salt Wells Group, near Coalville, Utah, *Ostrea sannionis*, *Arca coalvillensis*, *Lunatia utahensis;* from Last Chance creek, Southern Utah, *Inoceramus gilberti;* and from Upper Kanab, Utah, and Hilliard Station, Wyoming, *Cyrena erecta.*

He described, from the Sulphur Creek Group at Upper Kanab, Utah, *Turnus sphenoideus*, *Anchura ruida*, and *A. prolabiata.*

He described from the Henry's Fork Group at the head of Waterpocket canon, Southern Utah, *Plicatula hydrotheca;* from Lower Potato Valley and Upper Pine creek, Utah, *Inoceramus howelli;* from Middle Park, south of Grand river, Colorado, *Avicula parkensis.*

He described, from the Bitter Creek Group at Black Buttes, Wyoming, *Unio petrinus*, *U. propheticus*, *U. brachyopisthus*, *Neritina volvilineata*, *Viviparus plicapressus*, *Leioplax turricula;* from Almy coal mines, near Evanston, *Pisidium saginatum*, *Hydrobia recta;* from Point of Rocks, *Corbula subundifera;* from south base of Pine Valley Mountains, Utah, *Helix peripheria*, and from Musinia plateau, *Hydrobia utahensis.*

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* Geo. of Uinta Mountains.

Dr. F. V. Hayden* said the Dakota Group is composed of massive beds of sandstones, intersected with layers of clay, and forms some of the most conspicuous ridges or "hogbacks" along the eastern base of the Front or Colorado range. Its importance, however, varies in different localities as much as its texture; sometimes it is scarcely seen, and then again it forms one or more of the most important ridges. Its aggregate thickness is never great, varying from 200 to 400 feet, and may be represented by a very narrow belt on the map. West of the 100th meridian it has yielded very few organic remains, although it has a very extended geographical range. It is hardly ever wanting along the margins of the mountain ranges east of the Wasatch Mountains, in Utah. From its structure in the far West he regarded it as a sort of transitional group between the well-defined Cretaceous and the Jurassic below.

Dr. A. C. Peale measured a section of the Dakota Group beneath station 73, north side of Gunnison river, that presented a thickness of 536 feet, and another section at station 60, that presented a thickness of 651 feet.

The Fort Benton and Niobrara Groups are found in the valleys of Grand and Gunnison rivers, and on the North Fork of the Gunnison. A partial section between station 38 and station 80 gave a thickness of 753½ feet, and another section on Gunnison river, opposite Roubideau's creek, measured 687 feet. The estimated thickness, however, including the Fort Pierre Group, is from 1,500 to 2,000 feet.

On Coal creek there is a bluff, in the face of which are exposed 1,500 feet of light-gray and yellowish sandstones and shales, referred to the Fox Hills Group. And on the North Fork of the Gunnison the exposures are of greater thickness. On the ridge dividing Oh be Joyful creek from Anthracite creek, near station 32, a section of sandstones occurs 883 feet in thickness. Most of these sandstones have a metamorphosed appearance, and the ridge, in which they are exposed, is intersected with dikes. Below the strata of this section there are propably 1,000 feet of shales and sandstones to a series of coal-bearing strata on Oh be Joyful creek. The latter, according to Mr. Holmes' estimates, is about 2,000 feet above the Dakota Group.

Above these beds there is a series referred to the Lignitic Group from 7,000 to 8,000 feet in thickness, covering a large area extending from the Grand river to the Gunnison, beneath the basaltic plateaus west of Roaring Fork. The strata are conformable to the underlying

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*7th Rep. U. S. Geo. Sur. Terr.

Fox Hills Group, and it is difficult to determine where one formation ends and the next begins. From Dr. Peale's examination and study he deduced the following conclusions:

1. The lignite-bearing beds east of the mountains in Colorado are the equivalent of the Fort Union Group of the Upper Missouri, and are Eocene-Tertiary; also that the lower part of the group, at least at the locality 200 miles east of the mountains, is the equivalent of a part of the lignitic strata of Wyoming.

2. The Judith river beds have their equivalent along the eastern edge of the mountains below the Lignitic or Fort Union Group, and also in Wyoming, and are Cretaceous, although of a higher horizon than the coal-bearing strata of Coalville and Bear river, Utah. They form either the upper part of the Fox Hills Group, or a group to be called No. 6.

3. That the upper part of the Fox Hills Group is wanting in many parts of Eastern Colorado, and when present seems to be thin and destitute of coal.

F. M. Endlich surveyed the San Juan mining district, where he found the Dakota Group resting unconformably upon carboniferous sandstone. It consists of sandstones with occasional remains of plants, and has an estimated thickness of 800 to 1,000 feet. The Fort Benton Group, consisting of dark-gray shales, subject to considerable erosion from the action of water, is found from 400 to 600 feet in thickness. It contains beds of coal.

These groups are also developed on the San Miguel and on the Rio Dolores. A creek flowing scarcely five miles has at the junction with the San Miguel a canon 1,005 feet in depth. The entire canon is cut out of the strata of the Dakota Group, and yet the whole thickness is not exposed.

Prof. Leo Lesquereux found the flora of Point of Rocks related to that of Black Butte by nine identical forms or one-third of its known species, notwithstanding that there are two to three thousand feet of interposed measures. The distance between the two localities is only eleven miles, and the superposition of the strata is exposed so that the vertical thickness of the intervening rocks may be easily ascertained. He explained the scarcity of the bones of animals in the lower beds of the Lignitic, by the fact that, no animal, not even man, if once imbedded in soft peat, can get out of it, and also by the further fact that the coriaceous, ligneous plants of the bogs are not food for mammals.

He described, from the Lignitic at Point of Rocks, *Fucus lignitum*,

Salvinia attenuata, *Selaginella falcata*, *S. laciniata*, *Sequoia biformis*, *Widdringtonia complanata*, *Pistia corrugata*, *Ottelia americana*, *Dryophyllum crenatum*, *D. subfalcatum*, *Populus melanarioides*, *Trapa microphylla*, *Laurus praestans*, *Viburnum rotundifolium*, *Greviopsis cleburni*, *Rhus membranacea;* from Alkali Station, *Alnites inequilateralis*, *Juglans alkalina*, *Carpites viburni*; from Black Butte, *Sphæria rhytismoides*, *Sequoia acuminata*, *Diospyros ficoidea*, *Viburnum platanoides;* from South Park, near Castello ranch, *Hypnum haydeni;* from Grand Eagle Junction, *Lygodium marvinei;* from Golden, *Zamiostrobus mirabilis*, *Arundo obtusa*, *Palmacites goldianus*, now *Geonomites goldanus*, *Sabal communis;* from Middle Park, *Myrica insignis*, *Castanea intermedia:* from Fort Fetterman, *Betula vogdesi;* from Pleasant Park, Plum creek, *Ficus ovalis;* and from Evanston, *Ficus pseudo-populus*.

He described, from the Dakota Group, near Fort Harker, Kansas,* *Sequoia condita*, *Myrica cretacea*, *Dryophyllum latifolium*, *Ficus distorta*, *F. laurophylla*, *Laurus proteacfolia*, *Daphnogene cretacea*, *Aralia saportanea*, *Hedera schimperi*, *H. platanoidea*, *Cissites acuminatus*, *C. heeri*, *Ampelophyllum attenuatum*, *Menispermites populifolius*, *Aspidiophyllum trilobatum*, *Protophyllum crednerioides;* from Clay Center, Kansas, *Aralia concreta*, *A. towneri*, *Menispermites ovalis*, *M. cyclophyllus*, *Sterculia lineariloba;* from the Fort Benton Group, near the San Juan river, in southwest Colorado, *Dryophyllum salicifolium*, and *Ilex strangulata*; and from Spring Canon, *Andromeda affinis*.

Prof F. B. Meek† described, from the Dakota Group, southwest of Salina, Kansas, *Trigonarca salinaensis*; from the Big Sioux river, *Arcopagella macrodonta;* from the Fort Benton Group, at the head of Wind River Valley, Wyoming, *Mortoniceras shoshonense:* from the Fort Pierre Group on Cherry creek, near the mouth of Sage creek, Dakota, *Odontobasis ventricosa;* from the Fox Hills Group, Moreau river, *Microstizia millepunctata*, *Ostrea subalata*, *Pyropsis bairdi*, var. *rotula*, and *Scaphites conradi*, var. *intermedius;* from the base of the Black Hills, *Sphæriola warrenana;* from 90 miles below Fort Benton on the Missouri, *Sphæriola endotrachys;* from Yellowstone river, 150 miles from its mouth, *Fasciolaria gracilenta;* from the Fort Union Group, at Clear Fork of Powder river, Montana, *Hydrobia eulimoides:* from the Judith River Group, at the mouth of Judith river, Montana, *Hydrobia subconica*, and *Valvata montanensis*.

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* 7th Rep. Hayden's U. S. Geo. Sur. Terr.
† Invert, Cret, and Tert. Foss., vol. ix., Hayden's Sur.

R. P. Whitfield* described, from the Judith River Group, at the mouth of Judith river, *Tapes montanensis*, *Mactra maia*, *Sanguinolaria oblata*, and *Thracia grinnelli*.

W. M. Gabb† described, from the Cretaceous of New Jersey, *Pentacrinus bryani*, *Goniaster mammillata*, *Scalpellum conradi*, *Nautilus bryani*, *Surcula strigosa*, *Opalia thomasi*, *O. cyclostoma*, *Laxispira lumbricalis*, *Ostrea bryani*, *Paliurus triangularis*; from the Ripley Group, of North Carolina, *Exilifusus kerri*, *Fasciolaria kerri*, *F. obliquicostata*, *Gyrotropis squamosus*, *Ataphrus kerri*, *Idonearca carolinensis*; from Patula creek, Georgia, *Drillia georgiana*, *Tritonium edentatum*, *Nassa globosa*, *Fasciolaria crassicosta*, *Ptychosyca inornata*, *Aporrhais bicarinata*, *Bivonia cretacea*, *Pholadomya littlei*, *Schizodesma appressa*, *Tellina georgiana*, *Gari elliptica*, *Peronæoderma georgiana*, *Trigonia angulicosta*, *Idonearca littlei*, *Trigonarca cuneata*, *Ostrea littlei*, *O. exogyrella*; and from Alabama, *Idonearca alabamensis*, and *Neithea complexicosta*.

J. W. Spencer‡ examined the country between the Upper Assineboine river and lakes Winnipegosis and Manitoba, and found rocks of Cretaceous age on Thunder Hill, at a height of nearly 800 feet above Swan lake. Following the course of Swan river below Thunder Hill, there are numerous exposures of these rocks for about thirty miles, which, with those of Thunder Hill, furnish a thickness of from 550 to 650 feet. There are also numerous exposures along the Bell river in the Porcupine mountains. They repose on rocks of Devonian age. Mr. G. M. Dawson, from the calcareous character, the microscopic forms, and the presence of *Inoceramus* and *Ostrea congesta*, referred the rocks to the Niobrara Group.

Prof. J. F. Whiteaves§ described, from the Cretaceous of the Queen Charlotte Islands, *Ammonites perezianus*, *A. loganarus*, *A. richardsoni*, *A. skidegatensis*, *A. carlottensis*, *A. laperonsianus*, *A. filicinctus*, *A. crenocostatus*, *Amauropsis tenuistriata*, *Pleurotomaria skidegatensis*, *Martesia carinifera*, *Pleuromya carlottensis*, *Pholadomya ovuloides*, *Callista subtrigona*, *Trigonia diversicostata*, *Meleagrina amygdaloidea*, and *Syncyclonema meekanum*.

Prof. E. D. Cope‖ described, from the Judith River Group of Montana, *Aublysodon lateralis*, *Lælaps incrassatus*, *L. explanatus*, *L. falculus*,

* Carroll to Yellow Stone Nat. Park,
† Proc. Acad. Nat. Sci.
‡ Geo, Sur. of Canada, 1876.
§ Mesozoic Foss., Pt. 1.
‖ Proc. Acad. Nat. Sci.

Dysganus encaustus, *D. haydenanus*, *D. bicarinatus*, *D. peiganus*, *Diclonius pentagonus*, *D. perangulatus*, *D. calamarius*, *Monoclonius crassus*, *Paronychodon lacustris*, *Compsemys imbricarius*, *C. variolosus*, *Polythorax missouriensis*, *Hedronchus sternbergi*, *Ceratodus eruciferus*, *C. hieroglyphus*, *Myledaphus bipartitus*, *Lælaps hazenanus*, *L. lævifrons*, *Zapsalis abradens*, *Champsosaurus profundus*, *C. annectens*, *C. brevicollis*, *C. vaccinsulensis*, *Scapherpeton excisum*, *S. favosum*, *S. laticolle*, *S. tectum*, and *Hemitrypus jordananus*; and from the Fox Hills Group, of Montana, *Uronautus cetiformis*.

Prof. O. C. Marsh* described, from the upper Cretaceous of Western Kansas, *Ichthyornis victor*, *Hesperornis gracilis*, *Lestornis crassipes*, *Pteranodon comptus*, *P. ingens*, *P. longiceps*, *P. occidentalis*, *P. velox*. and *P. gracilis*, now *Nyctosaurus gracilis*.

In 1877, Arnold Hague† estimated the thickness of the Cretaceous on the outlying ridges and foot-hills, east of the Colorado range, as follows: Dakota Group, 300 feet; Colorado Group, 1,000 feet; Fox Hills Group, 1,500 feet; and Laramie Group, 1,500 feet.

The Dakota beds are essentially a sandstone formation, and as they are usually hard and compact, frequently almost a quartzite, they form a well-defined horizon. Lying between the easily-eroded Jurassic marls and clays below, and the overlying blue shales, clays and crumbling rocks of the Colorado Group above, the Dakota beds are usually a conspicuous feature in the ridges, which form the foot-hills of the main range. In approaching the mountains from the Great Plains, the Dakota beds are especially prominent, as they form the outlying member of the series of upturned sedimentary beds, which rise so abruptly above the plain; for although the overlying Colorado group is perfectly conformable, they never occur high up on the long ridges, which form a sort of barrier between the level country and the mountain region beyond.

The Colorado Group is used to represent the Fort Benton, Niobrara, and Fort Pierre Groups. The Fort Benton Group is only exposed along the base of the abrupt ridges, and consists of dark, plastic clays, at times distinctly bedded, and frequently occurring as thinly-laminated paper shales. The lower beds are always more or less arenaceous, with interstratified beds of purer clay, while the upper beds sometimes carry thin seams of argillaceous limestone, which, in many places, can not be distinguished from similar beds in the Niobrara. Along the Laramie

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* Am. Jour. Sci. and Arts, 3d Ser., vol. xi.
† Geo. Sur. 40th parallel.

Hills, this group is somewhat difficult to recognize, but in Colorado it may be traced for long distances in well defined north and south lines.

The Niobrara Group, although much thinner, is more easily recognized. It frequently blends so completely with the overlying Fort Pierre Group that it is extremely difficult to separate them.

The Fox Hills Group, east of the Colorado Range, is characterized throughout by great uniformity in texture and physical habit, and consists of a coarse sandstone formation, showing only variations in color from reddish brown to reddish yellow. The strata pass by imperceptible gradations, into the Laramie series, offering no well-defined line of separation, both formations from top to bottom consisting of coarse sandstone. The Laramie Group may be traced along the Big Thompson and Cache la Poudre valleys, and then eastward up the valleys of the northern tributaries to the South Platte. The sandstones form the exposed banks along Crow and Lone Tree creeks, and may be traced northward, passing under the Tertiary of Chalk Bluffs. This group includes the valuable coal deposits at Erie, and the Marshall and Murphy mines, north of Golden, extending from within one-half mile of the base of the range far out upon the plains into Eastern Colorado.

The Laramie beds form the uppermost members of the great series of conformable strata that lie upturned against the Archaean mass of the Rocky mountains; all overlying strata resting unconformably upon the older rocks.

The Cretaceous rocks are distributed over the surface of the Laramie Plains. On Rock creek, a branch of Medicine Bow river, north of the Little Laramie, and near Rock Creek Station, the Fort Benton Group is exposed from 350 to 400 feet in thickness. In the North Park, the Dakota Group is estimated at 350 feet in thickness, and here the Fort Benton, Niobrara and Fort Pierre Groups have a combined thickness roughly estimated at from 1,500 to 2,000 feet.

The Medicine Bow river, after leaving the mountains, runs almost exclusively through beds of Cretaceous age, its course being guided by the clays and marls, and the overlying Fox Hills sandstone.

On the northern slopes of Elk Mountain, the most northern point of the Medicine Bow Range, are found all the beds from the coal measures to the Fox Hills sandstone, uplifted at high angles, lying against the Archaean formation. All the geological divisions are well represented. In the valley of the North Platte river the Fox Hills Group has an estimated thickness of between 3,000 and 4,000 feet.

The strata containing the coal beds, at the town of Carbon, 656 miles west of Omaha, Mr. Hague supposed to be Upper Cretaceous.

S. F. Emmons,* geologist of the division west of North Platte, said that Bridger's Pass, which connects the valleys of the Upper Sage creek and the south fork of the Little Muddy, has been eroded out of the soft beds of the Colorado Cretaceous. Along the northern and western borders of this valley extends a ridge of white massive sandstones of the Fox Hills Group, standing at angles of 10° to 25°, and curving in strike approximately with the shape of the ridge. To the north of the gap, they form a continuous ridge about 15 miles in length, showing a bluff face to the southwest toward Bridger's Pass, at the base of which are exposed the clayey beds of the Colorado Group. A thickness of 3,000 to 4,000 feet of heavy-bedded sandstones, mostly white and buff, with a few included beds of shale, and some thin seams of coal, dipping to the northward at an angle of 10° to 20°, is exposed.

In going northward from a point on the Little Muddy, about five miles west of the Sulphur Springs, a thickness of between 3,000 and 4,000 feet of beds of the Laramie Group, dipping northwest at an angle of 20°, is crossed. Of these, the lower 2,000 feet are composed of massive white and yellow sandstones, in which the shale beds are of subordinate importance. The upper sandstones are stained and striped in red, by iron oxide, and form ridges with considerable clayey valleys between. In the upper 800 feet are several coal seams, and near the top is a prominent bed of bright vermilion color, only a few feet in thickness, of fine-grained, hard, argillaceous material, abounding in well preserved impressions of leaves. This is overlaid by a white sandstone, about 200 feet in thickness, carrying a coal seam, which in turn is capped by a thin-bedded brown sandstone, which weathers into flags about three inches in thickness; the dip of these upper beds has shallowed to 10°, and to the north the beds of the Laramie Group are practically horizontal.

The exposures of the Fox Hills Group, as seen in Bear Ridge, near the valley of the Upper Tampa river, show a series of massive, white, fine-grained sandstones of several thousand feet in thickness.

The Cretaceous of the Uinta Mountain region consists of over 10,000 feet of beds of sandstones and clays, carrying coal seams, which are most abundant in the upper part of the series. The Dakota Group consists of about 500 feet of rather thinly-bedded sandstones, with some clay beds, having at its base the persistent conglomerate carrying small pebbles of black chert. The Colorado Group, about 2,000 feet in thickness, is made up mostly of clays and yellow marls, with

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* Geo. Sur. 40th parallel.

some sandstones at the base, which inclose one prominent coal-seam; the outcrops of this group are generally occupied by valleys. The Fox Hills Group consists of about 3,000 feet of heavily-bedded white sandstones, with a few coal-seams and comparatively little clay. The Laramie Group, whose actual thickness is not definitely ascertained, consists also of gray and white sandstones, often iron-stained, containing a greater development of clay beds, and very rich in coal seams. It is overlaid by an unconformable series of beds. The fauna of this group is brackish, and, locally, even fresh water forms are found associated with marine types.

In the valley of Bitter creek, the Fox Hills Group is estimated at 3,000 feet in thickness, and the Laramie at 6,000 feet. The latter is characterized by the greater development of clayey beds, and by the great number of coal seams, and by the presence of great quantities of leaves and plant remains, especially in the upper portion of the series. The beds are conformable, and were evidently deposited prior to the great period of plication and uplift in which the Rocky Mountains and the Uinta and Wahsatch ranges received their main elevation.

West of Bear River City, in Utah, along the face of the hills north of Sulphur creek, are exposed outcrops of the Fox Hills and Laramie Groups, from 5,000 to 7,000 feet in thickness, standing at angles of 85° to 90° west, and striking north 30° to 45° east, and consisting of heavy white sandstones with conglomerate beds, and passing to the westward into reddish brown sandstones. The beds of the Colorado Group west of the sandstone ridge, at the bend of Sulphur creek, expose a thickness not less than 5,000 or 6,000 feet. About two miles west of Bear River City, a railroad-cut, through a low ridge running out from the high ground forming the northeastern wall of the Sulphur Creek Valley, shows a section of about 150 feet of beds, separated by an interval, bare of outcrops, from the sandstones west of Bear River City, but corresponding with them in strike, and standing with an inclination of 70° to 80° to the southeast. It is formed of sandstones, marls and clays, with a few bituminous and gypsiferous seams, and is remarkable for the fine definition of its bedding-lines, the strata varying from half an inch up to a foot or more in thickness. The strata abound in fossils of fresh and brackish water types, viz.: *Unio*, *Corbula*, *Limnaea*, *Campeloma*, *Viviparus*, etc. They evidently belong to the conformable beds of the Laramie Group, and are overlaid a short distance to the north by horizontal strata of the Vermilion creek Eocene.

G. K. Gilbert* found the Cretaceous strata well displayed upon the flanks of the Henry Mountains, in Southern Utah, where they consist of four principal sandstones, with intervening shales, and have a thickness of 3,500 feet. They also contain thin beds of coal, one of which was observed at the foot of Mount Ellen, four feet in thickness. The lower 500 feet he referred to the Henry's Fork Group.

Dr. A. C. Peale,† geologist of the Grand river division, said that the massive, yellow silicious sandstone, in some places quartzite, at the base of the Cretaceous, is so well defined lithologically, that there has never been any difficulty in separating it from the overlying shales. Along the edge of the plains in Colorado, it is underlaid by greenish shaly beds, sometimes lignitic near the top, generally in part or wholly covered, which have always been referred to the upper part of the Jurassic. In the West these shaly beds still persist, and the massive sandstone, although still recognizable without difficulty, is much thinner, being only from 50 to 100 feet, and as we descend, in the sections carried below, we find other beds of silicious sandstone separated by shaly beds that are arenaceous, calcareous and argillaceous. In these beds, in 1874, he found a sassafras-leaf, which led him to refer them to the Lower Cretaceous. He drew an arbitrary line separating the Cretaceous and Jurassic. The beds below have the same lithological characters to the top of the red beds, with this exception, that limestones occur more frequently toward the base. In Arizona, G. K. Gilbert found Jurassic and Cretaceous fossils, associated in beds, resembling those usually referred to the Jurassic. He is of the opinion that we can not draw any line between the two formations, palæontologically, or lithologically, but for convenience in description it is best to draw an arbitrary line, which may be changed as we obtain more facts in relation to the formation.

There is a narrow outcrop of the Dakota Group on the south side of the Gunnison, above the Grand Canon, between the breccia and the granite. It appears, and is faulted, at the head of the Uncompahgre river and on Dallas Fork, the latter stream flowing on the line of the fault. Between this creek and the San Juan Mountains it rises until it reaches the summit of the foot hills, appearing from beneath the shales. On the Uncompahgre plateau, it dips gently to the eastward, and is the surface formation until we approach Escalante creek. Between the latter and Roubideau's creek, there are some isolated

* Rep. on the Geo. Henry Mountains.

† 9th Rep. Hayden's U. S. Geo. Sur. Terr.

patches of it. It is found along the western side of the Gunnison and forms the floor of the San Miguel plateau. Going north on the San Miguel plateau, we find the massive sandstones of the Dakota Group broken, and forming the tops of mesas between the streams rising in the Uncompahgre plateau and flowing into the San Miguel and Dolores rivers. Still further north it disappears altogether, until we approach Grand river, near the mouth of the Dolores.

In the Uncompahgre valley, on both sides of the river, until the canon is reached, there are exposures of the Fort Benton and Niobrara Groups. East of the Uncompahgre Agency the thickness of the beds is about 3,000 feet.

F. M. Endlich, geologist of the southeastern division, found the Dakota Group in the San Juan region forming a ridge parallel with the Piedra river, and having a thickness of more than 1,000 feet. He also discussed the age of the Lignitic Group of the Trinidad region, which spreads over an area of 750 square miles, and with Prof. Lesquereux supposed it to be of Tertiary age.

Dr. B. F. Mudge* said the Cretaceous in Kansas covers an area of over 40,000 square miles, or more than half the surface of the State. The Fort Benton, Fort Pierre and Fox Hills Groups are entirely wanting. The Dakota Group rests upon the Permian, and is succeeded by the Niobrara Group.

The average width of the Dakota is less than 50 miles, being somewhat less than that in the north part of the State, and more on the Smoky and Arkansas rivers. The dip is to the northwest, and very slight. It is conformable to the formation above it, and has a maximum thickness of about 500 feet.

The Niobrara Group occupies a belt of country about 30 miles in width, in the northern part of the State, but gradually widens to more than twice that extent in the Smoky Hill valley. The upper part is composed of chalk and chalky shales, the lower part which is called the Fort Hays Group, consists in its higher strata of heavy bedded limestone, under which is a friable, bluish black, or slate colored shale, which abounds in concretions or septaria, of all sizes, from one inch to six feet in diameter. The body of the concretions is of hard claymarl, with cracks lined with beautiful crystals of calc spar. The lower part has a thickness of 260 feet, and the upper part of 200 feet, making the total thickness 460 feet. It is succeeded by strata of Pliocene age.

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* 9th Rep. Hayden's U. S. Geo. Sur. Terr.

Alfred R. C. Selwyn* explored the country north and northeast of Fort George near the 54th parallel. The exploration was almost wholly within the Arctic watershed, and the basin of Peace river. From "The Fork"—Smoky river—up to Dunvegan, and thence to about five miles below Hudson's Hope, the rocks which are exposed along Peace river are mesozoic; they consist of dark, earthy shales, in parts characterized by numerous bands and septarian nodules of clay ironstone, many of which inclose large *Ammonites*, and they are also associated with sandy calcareous layers, holding other Cretaceous fossils, among which a species of *Inoceramus* is tolerably abundant, while in the dark argillaceous shales the scales of fishes are frequently observed. Descending Peace river, these dark shales are first seen at about six miles below Hudson's Hope. They are nearly or quite horizontal, and are exposed at intervals between this point and Fort St. John, in cliffs which rise almost perpendicularly from the water to heights of 50 or 100 feet. Near where they are first seen, the hills at a little distance back rise to 500 or 600 feet, and toward their summits present cliffs in which some thick beds of brown fine-grained sandstone crop out. About a mile below St. John, on the left bank, a section is exposed nearly 700 feet in thickness. These rocks are exposed at intervals down to The Fork, and also on Smoky and Pine rivers. On the latter stream the exposed thickness is estimated at 1,700 feet, and contains four thin seams of bituminous coal.

Prof. George M. Dawson, who explored the country between the 52d and 54th parallels, in British Columbia, found the equivalent of the Shasta Group in the vicinity of Tatlayoco lake. Along the eastern shore of the lake these rocks overlie those of the porphyrite series. They dip eastward, or away from the anticlinal axis, in which the lake lies, and form, at a short distance from its eastern margin, a rampart-like wall of mountains, from 2,000 to 3,000 feet high, and twelve miles in length. The rocks are compact, bluish-gray quartzites, or hard sandstones, and conglomerates of all grades in regard to size of particles, associated with blackish or dark-colored slaty and shaly beds, which recur frequently at different horizons. The thickness of the entire Cretaceous series on the east side of Tatlayoco lake is estimated at 7,000 feet. Their geographical extension is also great. He regarded the Jackass Mountain Group as the equivalent of the Shasta Group of California.

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* Geo. Sur. of Canada.

Prof. E. D. Cope* called the Judith River Group No. 6 Cretaceous. He showed its conformability with the underlying marine Cretaceous, and gave a section 332 feet in thickness, though its maximum is not less than 500 feet. His section in ascending order is as follows:

	Arenaceous marl (with Dinosaurian bones near the top)	125	feet.
Saurian Remains.	Sandstone, 1st	5	"
	Sandstone	6	"
	Impure lignite	2	"
	Sandstone, 2d	10	"
	Impure lignite	4	"
	Unio bed	30	"
	Rusty sandstone (with fresh water shells)	25	"
	Arenaceous marl (with petrified wood)	50	"
	Sandstone, 3d	15	"
	Marl	20	"
	Reddish shale	10	"
	Lignite	5	"
	Shale	7	"
	Black shale and lignite	3½	"
	Bed of *Ostrea subtrigonalis*	15	"
	Total	332½	feet.

The presence of Dinosaurians, gar fishes, turtles, *Physa*, *Viviparus* and *Unio* prove the fresh water character of the strata, while the *Ostrea* indicates a return to brackish water.

Dr. C. A. White† described, from the Judith River Group at Cow Island and Dog creek, a tributary of the Upper Missouri river, in Montana Territory, *Unio cryptorhynchus*, *U. senectus*, *U. primaevus*, *Anodonta propatoris*, *Bulinus atavus*, and *Physa copei*.

Prof. F. B. Meek‡ described, from near Laporte, Colorado, *Anomia rœtiformis;* from East Canon creek, Wasatch Range, Utah, *Cucullœa obliqua*, *Mactra emmonsi;* from Cooper creek, Laramie Plains, Wyoming, *Axinœa wyomingensis;* from Red creek, Uinta Mountains, Utah, *Mactra arenaria;* from East Canon creek, Utah, *Mactra utahensis*, *Tellina isonema*, *T. modesta*, *Gyrodes depressa*, and *Anchura fusiformis*.

Prof. C. A. White§ described, from east of Impracticable Ridge, Utah, *Ostrea prudentia;* from near Pueblo, Colorado, *Inoceramus*

* Bull U. S. Geo. Sur., Vol. 3., No. 3.
† Bull U. S. Geo. Sur., Vol. 3., No. 3.
‡ U. S. Geo. Expl., 40th parallel.
§ Wheeler's Sur. W. 100th Mer., Vol. 4.

flaccidus, *Mactra incompta;* from the Rio Puerco, New Mexico, *Idonearca depressa;* from Mount Taylor, New Mexico, *Lispodesthes lingulifera;* from Ojo de los Cuervas, New Mexico, *Ammonites laevianus;* from Paria, Utah, *Helicoceras pariense*, and *Serpula intrica.*

Prof. E. D. Cope* described, from the Fort Pierre Group of Kansas, *Pelycorapis berycinus;* and from the Niobrara Group of the Upper Missouri, *Elasmosaurus serpentinus*, and *Anogmius aratus.*

Prof. O. C. Marsh† described, from West Kansas, *Baptornis advenus;* from Texas, *Graculavus lentus*, *Diplosaurus felix;* from the Rocky Mountain region, *Nanosaurus agilis*, *N. victor*, *Apatodon mirus ;* and from the Dakota Group of Colorado, *Titanosaurus montanus.*

In 1878, Prof. C. A. White‡ surveyed a portion of Northwestern Colorado, and found the Dakota Group reaching an aggregate thickness of between 500 and 600 feet; the lower half consisting of a dark-colored, coarse, silicious, pebble-conglomerate, which is somewhat irregularly bedded and easily disintegrated; and the upper portion, consisting of a yellowish or brownish, rough, heavy-bedded sandstone, between which and the conglomerate some variegated bad-land sandstones usually exist.

The equivalent of the Fort Benton and Niobrara Groups he called the Colorado Group, which is also the equivalent of the Sulphur Creek Group. He united, under the name of the Fox Hills Group, both the Fox Hills and Fort Pierre Groups, the former of which has a thickness of 1,000 feet, and the latter of 800 feet. The strata that have been called by the name of the Fort Union Group, Lignitic Group, Bitter Creek Group, Judith River Group, and by other names, including the name of Laramie Group, proposed by Mr. King, he proposed to call Post-Cretaceous. The thickness of this group in Northwestern Colorado is at least 3,500 feet.

He described, from the Laramie Group,§ on Crow creek and Danforth Hills, in Northern Colorado, *Volsella regularis*, *V. laticostata*, *Nuculana inclara*, *Anodonta parallela*, *Corbicula cleburni*, *C. cardiniæformis*, *C. obesa*, *C. macropistha*, *Physa felix*, *Viviparus prudentia*, *Odontobasis formosa*; from Black Buttes Station, Wyoming, *Unio goniambonatus*, *U. aldrichi*, *Neritina baptista;* from Bear river, near the confluence of Sulphur creek, Wyoming, *Acella haldemani*, *Neri-*

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* Bull. U. S. Geo. Sur., Vol. 3, No. 3.
† Am. Jour. Sci. and Arts, 3d Ser., Vol. 14.
‡ 10th Rep. Hayden's U. S. Geo. Sur. Terr.
§ Bull. U. S. Geo. Sur., Vol. 4, No. 3.

tina naticiformis, *Viviparus couesi;* from near Evanston, *Helix evanstonensis*, and *Goniobasis endlichi.*

Prof. Leo Lesquereux* described, from the Fort Union Group, at Black Buttes, Wyoming, *Sequoia acuminata*, *Vitis sparsa*, *Greviopsis saportana*, *G. tenuifolia*, *Rhus pseudomeriani*, *Pòdogonium americanum*, *Carpites myricarum*, *C. glumæformis*, *C. mitratus*, *C. verrucosus*, *C. viburni*, *C. bursæformis;* from Golden South Mountain, Colorado, *Sabalites fructifer*, *Palmocarpon truncatum*, *P. corrugatum*, *P. subcylindricum*, *Populus ungeri*, *Laurus ocoteoides*, *Viburnum anceps*, *V. goldianum*, *V. solitarium*, *Fraxinus eocenica*, *Cornus suborbifera*, *Carpites oviformis*, *C. triangulosus*, *C. costatus*, *C. coffæformis*, *C. rostellatus*, *C. rhomboidalis*, and *C. minutulus* ; from the divide between the source of Snake river and Yellowstone lake, *Geonomites schimperi*; from Raton Mountains, near Fischer's Peak, New Mexico, *Geonomites tenuirachis*, *G. ungeri* ; from Castello's Ranch, near South Park, Colorado, *Fraxinus brownelli*, *Sapindus stellariæfolius;* from Florissant, *Carpites pealei* ; from Evanston, Wyoming, *Laurus socialis*, *Carpites laurineus*, *C. utahensis* ; from Bridger's Pass, Wyoming, *Laurus utahensis*; from above Spring Canon, near Fort Ellis, Montana, *Dombeyopsis platanoides*, *Celastrinites lævigatus;* from Carbon, Wyoming, *Cratægus æquidentata;* from Fort Steele, *Carpites valvatus*, and from other places, *Quercus cinereoides.*

Mazyck & Vogdes† described, from the Cretaceous beds reached in artesian boring, at Charleston, South Carolina, at the depth of 1,880 feet below the surface, *Anomia andersoni.*

In 1879, F. M. Endlich‡ described the Cretaceous east of the Wind River range in Wyoming, and separated it in ascending order into:

1. The Dakota Group, consisting of yellow and brown shales, interstratified with sand stones of the same color. In the shales, above some of the thin beds of sandstone, there are slight indications of coal. The seams are but half an inch thick, and the coal is of that variety called jet coal. Higher up the sandstones predominate, separated by thin layers of homogeneous, dark shales. Near the top there is a heavy bed of shale, which is covered by massive white, yellow and brown sandstones. A small thickness of arenaceous shales closes the group. This is the general section of the Dakota, as exposed west of the anticlinal axis. In some of the upper sandstones indis-

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*Tert. Flora., Vol. 7, Hayden's Sur.
†Proc. Acad. Nat. Sci.
‡11th Ann. Rep. U. S. Geo. Sur. Terr.

tinct remains of plants occur, and in the higher shales a *Gryphæa.* The thickness is about 400 feet.

2. The Colorado Group, consisting of an extensive series of dark gray, slightly calcareous shales. They are thinly laminated, easily eroded, and become light gray or white upon exposure. Covering the highest portions of the region lying between Sheep Mountain and the base of the third chain, they present comparatively steep bluffs parallel to their strike, and rounded surfaces along their dip. A few banks of argillaceous limestone may be found within them. Within the upper third the shales are more arenaceous than lower down. A cold sulphur spring near Camp Brown seems to take its rise in these shales which must be regarded as a very prolific source for alkaline compounds of a highly soluble nature. Within the shales there are small inclusions of pyrite. Upon decomposition of this and the shales various salts are formed. The thickness of this group is about 600 feet, increasing southerly to 900 feet.

3. The Fox Hills Group, consisting in the lower part of brown and yellow shales, interstratified with thin beds of sandstone. Some of the shales are very dark and carbonaceous. Above this alternating series there is a considerable thickness of yellow and brown shales. As a rule, they are arenaceous, but some of them quite free from sand. Small particles of mica occur throughout. Higher up, sandstones set in again, containing, together with thin seams of shales, small deposits of coal. The upper part is formed by thinly-bedded, micaceous and argillaceous sandstones, covered by a thick stratum of the same material. The thickness is estimated at 500 feet.

About two miles west of Camp Brown, a very interesting hot spring occurs, which rises in the beds of this group. It is known as the Hot Sulphur Spring. The temperature is from about 100° to 110°, and varies but little with the weather. The bright green and blue water is contained within an elliptic basin 315 feet long and 250 feet wide. A constant bubbling up of carbonic-acid gas gives it the appearance of boiling. The mineral constituents held in solution by the water are iron, lime, magnesia, soda and potash. They seem to be contained in the form of sulphates, carbonates and chlorides. The heat which supplies the warmth of the water is supposed to be due to chemical changes going on within the strata through which the moisture finds its way. A petroleum spring also occurs near Camp Brown, originating probably in the same rocks.

The Laramie Group consists of a succession of shales and yellow

sandstones, forming low, long-continued bluffs. The thickness is estimated at 400 feet.

The yellow and white sandstones of the Dakota Group occur in the northern portion of the Sweetwater Hills. East of Elkhorn Gap they are much folded and plicated. In Whisky Gap, the strata curve around the Western base of the Seminole Hills, with a partiversal dip, and a short distance farther west they take part in an anticlinal upheaval. The thickness is estimated at about 700 feet.

The Colorado Group occurs also near Elkhorn Gap, and in Whisky Gap. At the latter place the shales are dark gray, finely laminated, and have a thickness of 650 to 700 feet.

The Fox Hills Group, in Whisky Gap, forms sharp, low ridges, participates in the stratigraphical disturbances, and has an estimated thickness of 1,000 feet, which increases toward the south. Near Salt Wells, this group is well developed, and occupies a prominent position. A valley of approximately semicircular shape, lies directly north of the railroad, bordered by steep brown bluffs of shales and sandstones of this group. Dipping off in every direction, they present a most typical partiversal arrangement of the strata. Near the base, they are composed of thinly-bedded sandstones. These are followed by yellow and brown shales, more or less arenaceous and micaceous. Above these there is a succession of sandstones and shales, containing carbonaceous strata. A recess in the bluffs is caused by the higher series of shales. The latter are covered by sandstone strata of varying thickness, separated from each other by shales. Some good coal is found in this horizon. Near the top, massive yellow sandstones are overlaid by thin beds of shale and white sandstone. On every side the beds are conformably overlaid by strata of the Laramie Group. The thickness is from 1,200 to 1,300 feet.

The Laramie Group has a wide distribution in the southern area of this territory. On the west side of the anticlinal it can be traced nearly to Whisky Gap, and probably juts against the granite of the Sweetwater Hills. From the stratigraphical structure of the entire region it is ascertained that this group forms a basin, upon which the younger strata are conformable. It is composed of sandstones, shales, marls, clays and coals. Near the base, heavy sandstones set in, soon superseded, however, by shales. These contain strata of sandstones at varying intervals. A number of coal-beds overlie the sandstones. The coal is generally covered by a comparatively thin stratum of sandstone, upon which follow clays, shales and arenaceous marls. Higher up a

succession of sandstones is interstratified with shale. Selenite is common in the shale. The higher members of the group are composed of yellow and white sandstones, containing beds of coal, and dark and often carbonaceous shales. Sandstones mediate the transition into the lower Tertiary groups. The lower coal-horizon is the most productive. The total thickness of this group west of Rawlings Springs, and from there northward, is estimated at 1,600 feet.

The decomposition of pyrite in dumps from coal banks, produces a spontaneous combustion of the coal which changes the color of the shales to a brilliant red. In the same manner probably the coal at places in the bank has taken fire and burnt as long as the supply of oxygen could sustain a flame. Through this process of metamorphosis by heat the overlying beds, containing more or less hydrated ferric oxide, were changed to a bright vermilion color. Sandstones occur, the faces and edges of which have been literally glazed by the long continued action of heat. Fragments are firmly baked together, and resemble cinders from a furnace. Purely argillaceous shales and clays have been thoroughly fritted and altered into very hard, compact porcelain jasper. Throughout the area covered by the Laramie Group, and in some of the Wasatch beds red colored strata occur which have been produced by these causes.

Dr. A. C. Peale,* estimated the thickness of the Laramie Group on Smith's Fork, and in the Bear River region, near the western shore line of the Wahsatch lake, at 5,000 feet.

Geo. M. Dawson,† explored the Cretaceous in British Columbia, on the headwaters of the Skagit, west of the main axis of the range, which forms the watershed, between that river and the Similkameen. The trail traverses the area in a general northeast direction for nearly thirteen miles. A section occurs on the trail immediately east of the crossing of the north branch of the Skagit, representing a thickness of 4,429 feet. The rocks are much disturbed, are lying at all angles up to vertical, and have suffered considerable hardening and alteration. They consist, generally, of sandstones, conglomerates and argillites.

Still further north-westward, from the vicinity of the mouth of Anderson river and Boston Bar, they were found to extend, in a long, narrow trough, nearly coinciding, in the main, with the Frazer river, with a general bearing of about N. 70° W., to the vicinity of Lillooet and Fountain, a distance of about 80 miles. The estimated thickness is

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* 11th Ann. Rep. U. S. Geo. Sur. Terr.
† Geo. Sur. of Can.

5,000 feet. They were also found on the Thompson, below its junction with the Bonaparte. The thickness on Tatlayoco, 220 miles northeastward from Skagit valley is estimated at 7,000 feet. These rocks are regarded as of the same age as the Shasta Group of California.

Prof. C. A. White* described, from the Fox Hills and Fort Pierre Group, at Cimarron, New Mexico, *Caryophyllia johannis*, *C. egeria*, *Crassatella cimarronensis;* from Hilliard Station, U. P. R. R., Wyoming, *Placunopsis hilliardensis*, *Neritina incompta;* from Coalville, Utah, *Neritina patelliformis*, var. *weberensis;* from Monument creek, near Colorado Springs, *Palinurus pentangulatus;* from the mouth of the Saint Vrains, Northern Colorado, *Baroda subelliptica*, *Pachymya herseyi*, *Actaeon woosteri*, *Actaeonina prosocheila;* from west of Greeley, Colorado, *Tancredia coelionotus*, *Glycimeris berthoudi* and *Anchura haydeni;* from the Cretaceous, at Salado, Bell County, Texas, *Exogyra valkeri;* from Dennison, Texas, *Anchura mudgeana;* from Helotes, Bexar County, Texas, *Turritella marnochi:* and from the Cretaceous, at the head of Waterpocket Canon, Southern Utah, *Cardium trite.*

He† described, from the Cretaceous, on Fossil Creek, 16 miles west of Greeley, and 6 miles south of Fort Collins, Colorado, *Chetetes (?) dimissus*, and *Beaumontia (?) solitaria.*

Prof. J. F. Whiteaves‡ described, from the Cretaceous rocks of the Sucia Islands, *Nautilus suciensis*, *Ammonites selwynanus*, *Surcula suciensis*, *Cerithium lallierianum*, var. *suciense*, *Amauropsis suciensis*, *Cirsotrema tenuisculptum*, *Stomatia suciensis*, *Cinuliopsis typica*, *Teredo suciensis*, *Linearia suciensis*, *Veniella crassa*, *Laevicardium suciense*, *Inoceramus cripsi*, var. *suciensis;* from Vancouver Island, *Ptychoceras vancouverense*, *Opis vancouverensis*, *Discina vancouverensis*, *Smilotrochus vancouverensis;* and from Hornby Island and Nanaimo river, *Potamides tenuis*, var. *nanaimoensis*, and *Periploma suborbiculatum.*

In 1880, Prof. C. A. White§ said that the geographical limits of the Laramie Group are not yet fully known, but strata bearing its characteristic invertebrate fossils have been found at various localities within a great area, whose northern limit is within the British Possessions, and whose southern limit is not further north than Southern Utah and Northern New Mexico. Its western limit, so far as known, may be stated as approximately upon the meridian of the Wahsatch

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* 11th Rep. Hayden's U. S. Geo. Sur. Terr.
† Bull U. S. Sur., Vol. 5, No. 2.
‡ Mesozoic Foss., Part 2.
§ Cont. to Pal. No. 4, 12th Rep. U. S, Geo. Sur. Terr.

range of mountains, but extending as far to the southwestward as the southwest corner of Utah, and its eastern limit is far out on the great plains, east of the Rocky Mountains, where it is covered from view by later formations and the prevailing debris of the plains. These limits indicate for the ancient Laramie sea a length of about 1,000 miles north and south, and a maximum width of not less than 500 miles. Its real dimensions were no doubt greater than those here indicated, especially its length; and we may safely assume that this great brackish-water sea had an area of not less than 500,000 square miles. The present range of the Rocky Mountains, which has been entirely raised as a mountain range since the close of the Laramie period, traverses almost the entire length of this great area, and far the greater part of the other extensive and numerous displacements which the strata of the different geological ages have suffered within that great area, have also taken place since all the Laramie strata were deposited, although some of those changes thus especially referred to began before the close of the Laramie period.

The invertebrate fauna consists almost wholly of brackish-water, fresh-water and land mollusca. Species belonging to all three of these categories are often found commingled in the same strata, but it is also often the case that certain strata, sometimes only thin layers, which contain the fresh-water and land molluscs alternate with those which contain the brackish-water species. All the species of fresh-water and land mollusca which prevailed during the Laramie period, seem to have ceased with the disappearance of their contemporary brackish-water forms, although they were succeeded by other fresh-water and land species.

He described from Point of Rocks' station, Bitter Creek valley, Wyoming, *Axinæa holmesana;* from the mouth of Sulphur creek, Bear river valley, Wyoming, *Rhytophorus meeki;* from the Cretaceous of Collin county, Texas, *Ostrea blacki*, *Exogyra winchelli*, *Pteria (?) stabilitatis;* from Bexar county, Texas, *Exogyra forniculata;* from Bell county, Texas, *Pachymya compacta*, *Thracia myæformis;* from the estuary strata of the age of the Fox Hills Group at Coalville, Utah, *Anomia propatoris;* from the Fox Hills Group at Cimarron, New Mexico, *Barbatia barbulata;* from Dodson's Ranch, near Pueblo, Colorado, *Lispodesthes obscurata;* from the Dakota Group, Saline county, Kansas, *Pteria salinensis*, *Gervillia mudgeana*; from the Fort Pierre Group at Fort Shaw near Muscleshell river, Montana, *Tessarolax hitzi;* and from the Cretaceous of Yellow Stone river, Montana, *Fasciolaria alleni.*

Prof. R. P. Whitfield described, from near San Antonio, Texas, *Paramithrax (?) walkeri.* And Prof. O. C. Marsh* described, from the Cretaceous chalk of Kansas, *Holosaurus abruptus.*

To conclude this cursory review of the growth of our knowledge of the Cretaceous formation of North America, I will add a few observations upon the present state of the science. The Cretaceous is found either exposed upon the surface or covered by the Tertiary, forming a border of variable width, on the eastern coast, from New York to Florida. It constitutes the surface rocks, or is overlaid with the Tertiary at all places south of the 33d parallel, with the exception of limited areas in the mountain regions. It extends up into Tennessee, spreads over all Mississippi, and reaches southern Illinois. West of the 97th meridian from the 33d parallel to the Arctic ocean, the whole country is covered with this formation, with the exception of limited areas in the mountain regions, or inconsiderable extensions of land, where it has been swept away, and an area of some magnitude north and west of Hudson's Bay. This of course includes the area covered by the Tertiary. It is found east of the 97th meridian, extending into Iowa, Minnesota, and some parts of British America. Or approximately stated, the Cretaceous now forms the surface rock, or is overspread by the Tertiary, over more than half the area of the North American Continent, and from the extensive denudation which it has evidently suffered, we may fairly presume, that at the commencement of this formation the continent was an island of less than one third its present dimensions.

In the east and south the formation is exclusively a marine deposit, but in the west, over great areas, the marine Cretaceous is succeeded by a brackish or fresh water Cretaceous deposit. In the east it never exceeds half a mile in thickness, but in the west the marine Cretaceous sometimes exceeds a mile in thickness, and is followed by the brackish and fresh water deposits, which are also more than a mile and sometimes even two miles in thickness. This formation is, therefore, pre-eminently the building deposit or land making deposit of the North American Continent.

The brackish and fresh water deposits were first named the Fort Union or Lignitic Group, and there is no reason known to the author, why these deposits, wherever found, should bear any other geological name. It is true that the name Bear River Group was given to a group of rocks lower than those first named the Fort Union Group, but

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* Am. Jour. Sci. and Arts, 3d Ser., Vol. xix.

the separation has not been maintained, and the authors, instead of extending the Fort Union Group to include these rocks, have called both the Fort Union and Bear River Groups the Laramie Group. Prof. White, and some other authors, call the rocks Post-Cretaceous. This is not objectionable, because it is treating them with reference to their geological position, and not proposing a new name for a group of rocks. If it is desirable to retain the name Bear River Group, it should be applied to the rocks below the Fort Union Group, and in no event can the Fort Union Group be swallowed up by another name for the same group of rocks. A great many synonyms have been proposed for this Group, some of which it is difficult to wipe out, and others will burthen the science for a longer or shorter period, but, finally, we may hope for their burial in oblivion. Any one can propose to call an exposure of rocks, at any place, by a new name, but it requires a palæontologist to determine the age of the rocks and to refer them to their proper position in the geological column. A little reflection, therefore, will satisfy the reader, that proposing a new name for a group of rocks, wherever exposed, without giving the palæontological reasons for so doing, is an evidence of ignorance, and most frequently we find those who do it are suffering from downright stupidity.

The plants which have been described, from the Cretaceous rocks in question, have been referred to about 150 genera, and number about 500 species. About 50 of these genera are now extinct, and about 100 are living. The larger part are from the Fort Union Group of the West, and from their intimate relation with living forms, the great palæo-botanist, Prof. Lesquereux, referred the rocks to Eocene age. The testimony, however, of the animal remains, which Prof. Cope was the first to discover, has proven that they must be referred to the upper or later Cretaceous. This determination has, if we may trust investigations of our fossil botanists, specifically united the Cretaceous era with the present time. For the living plants, *Corylus americana*, *C. rostrata*, *Davallia tenuifolia*, and *Onoclea sensibilis* have been identified among the fossils from the Fort Union Group. It is likely that too much confidence in this identification may lead to error, for as yet we may fairly suppose that we know but little of the vegetable life of this vast period of time in comparison with what will be known in a few decades. And better specimens than those upon which the identifications have been made may show specific distinctions. It is sufficient that the forms so much resemble the living as to be mistaken for them, to show how closely the living forms are connected with the ancient dead.

The relation between the invertebrate kingdom of the Cretaceous period and the living invertebrates is shown (according to present identifications) by the survival of more than one third of the Cretaceous genera, though all Cretaceous species have become extinct. The survival, however, in different classes, is by no means uniform. In the class Polypi, of sixteen Cretaceous genera, six are living. In the class Echinodermata, of twenty-two genera, eight are living. In the class Bryozoa, of thirty-two genera, nine are living. In the class Brachiopoda, of six genera, five are living. In the class Gasteropoda, of one hundred and seventy-four genera, ninety-six are living. In the class Lamellibranchiata, of one hundred and sixty-four genera, seventy are living. But in the class Cephalopoda, where there were more than thirty genera and subgenera, all have become extinct except a single genus, the *Nautilus*.

The connection between the vertebrates of the Cretaceous period, and the living vertebrates, is, seemingly, much farther removed. No Cretaceous genera of birds or mammals survive. In the class Reptilia, where more than seventy-five Cretaceous genera have been determined, only three genera are known to have survived, *Crocodilus*, *Trionyx* and *Emys*. A few species of fishes, found in the Cretaceous, have been referred to living genera, and probably some of them are correctly so referred; but from the great differentiation observed in the vertebrates, during the long period of time which has transpired, we can not expect to find many forms preserving unchanged their ancient outlines, though we may be able to trace backward the living genera into what we call distinct ancestral genera or families.

This closes our remarks upon the Mesozoic period, and we will now take up the Cænozoic. There is no great break in animal or vegetable life in passing from the Mesozoic to the Cænozoic, as early geologists, from very limited observations, supposed. Indeed, it may be said to be a most propable hypothesis that there are no breaks in genealogical trees. All organic life has descended from ancestral forms, and among the vertebrates, in the later geological periods, profitable accretions or accessions of important parts or functions have been developed in successive generations. This will become more apparent as we pass from one group of rocks to another in the Tertiary period.

[To be Continued.]

*ARCHÆOLOGICAL EXPLORATIONS NEAR MADISONVILLE, OHIO.**

By Charles F. Low.

PART III.

JANUARY TO JUNE 30, 1880.

On Friday, January 2d, skeleton No. 362, an adult, in horizontal position, head south, length 5 feet 3 inches, was found at a depth of 22 inches. An imperfect vessel was taken from the left side of the head. About three feet southwest of the above, the remains of a child (No. 363), probably three years of age, were uncovered; position horizontal, head south, depth about one foot.

Skeletons Nos. 364-5, two children about four years of age, were next exhumed; the first lay horizontally, head south, face down; the other was immediately under the preceding skeleton, head south, but with the face upward; depth 15 inches. A perfect vessel was found at the right of the cranium of this skeleton.

January 3d, skeleton No. 366, an adult male in horizontal position, head southwest, face upward, length 5 feet 9 inches, depth 14 inches. These remains were west of No. 362, and six feet distant; No. 363 was situated between these two about an equal distance from both.

An ash pit was also opened to-day, six feet in depth; leaf mold and sand 24 inches, ashes 48 inches; it contained the usual animal remains and relics.

January 7th, skeleton No. 367, an adult male in horizontal position, head south, length 5 feet 6 inches; the lower extremities were flexed to the northwest, and the hands were folded over the pelvis; depth 22 inches.

Skeleton No. 368 was immature, length 4 feet 3 inches, in horizontal position, head south; depth two feet.

On January 9th the skeletons of two children were discovered immediately east of No. 367, and possibly the lower extremities of that skeleton had been flexed to avoid contact with these remains; No. 369 was a child about four years of age, position horizontal, head south:

* The present paper, like the two preceding ones on the same subject, has been prepared by Mr. Charles F. Low, at the request of the Committee on Publication, of the Literary and Scientific Society of Madisonville, O.

depth 19 inches. A perfect vessel was found at the right side of the head. No. 370 was immature, irregularly doubled up, head south, at a depth of 20 inches.

On January 10th one of the deepest ash pits yet discovered was opened and explored; diameter 3 feet 4 inches, depth 8 feet 5 inches, the layer of leaf-mold 20 inches, sand 33 inches, ashes 48 inches. A perfect grooved bone implement, one long flint-drill, grooved stone hammer, and a large quantity of animal remains, shells and sherds were taken from this pit. In the ashes at the bottom of the pit, a human atlas and axis were found.

Skeleton No. 371 was exhumed on January 16th, an adult male in horizontal position, head south, length 5 feet 6 inches, depth 4 feet 6 inches.

On Saturday, January 17th, skeleton No. 372, a child about ten years of age, was found 2 feet 10 inches west of and at right angles with the preceding skeleton; position horizontal, head east, depth 15 inches.

On Tuesday, January 20th, an ash pit was opened 3 feet 4 inches in diameter, and 6 feet in depth; the layer of leaf mold was 21 inches, then a layer of ashes 36 inches, with sherds, Unio shells, animal remains and burnt limestones; third, a layer of charcoal about 3 inches in thickness, and below this, 12 inches of pure, grayish ashes. *In this ashes was found an entire human skeleton.*

This skeleton (No. 373) was lying in the bottom of the pit on its back, head toward the northwest, with the lower limbs sharply flexed on the thighs. Surrounding the skeleton were a number of flat limestones ten or twelve inches square, set on edge, forming a wall around the base of the pit. All these stones showed distinctly the marks of fire, but must have been burned before placing in their present position, as a very careful examination was made of the walls and bottom of the pit and no traces of the action of fire were visible. (See fig. 32.)

The discovery of human remains in undisturbed position at the bottom of this ash pit, furnishes some clue to the purposes of these excavations, and favors the view, which has been entertained by the writer and others, that they were probably places for temporary burial, from which the human remains have been removed for interment in some of the numerous sepulchral tumuli, usually designated "Battle Mounds," or "Sacrificial Mounds."

Why may not these ash pits and remains be contemporaneous with the Mound Builder?

That the ash pits are very ancient is evident from the fact that sub-

sequent interments, in both sitting and horizontal positions, have been made directly over these excavations since the removal of the human remains, and forest trees of several hundred years' growth are now growing over these comparatively later interments.

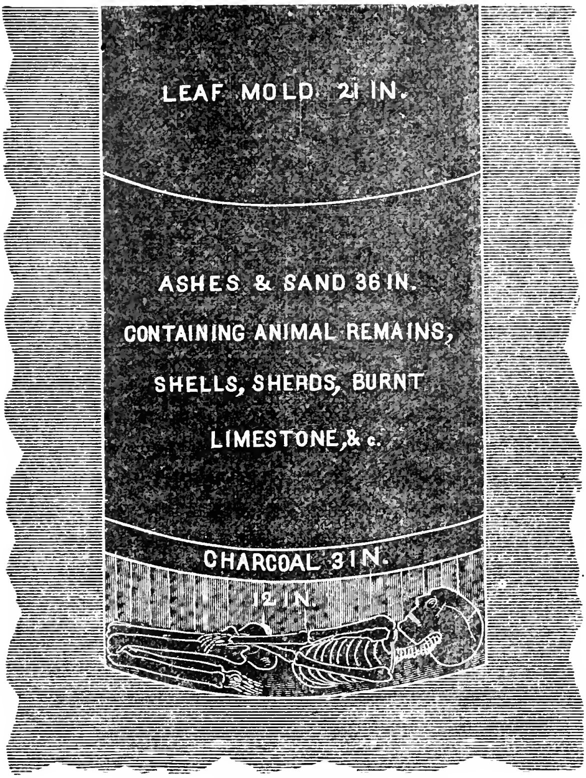

Fig. 32. Ash Pit with Human Remains.

What became of the Mound Builder, *i. e.*, those who raised the mounds of earth over their dead, is a question which has puzzled the archæologist. With the numerous evidences of long occupancy of this part of the country by these people, the theories of extermination or migration are not satisfactory solutions of the question.

The late Prof. E. B. Andrews, who took great interest in our explorations, expressed his opinion that our discoveries in this cemetery would direct attention to a new line of investigation, and that explorations for the remains of these prehistoric people would not in the future be confined to opening mounds.

E. G. Squire also remarks, in Abor. Mon. of New York, pp. 125-6, that—

"The mounds of the West can be regarded only to a limited extent as the burial places of the people who built them, * * * and we must seek elsewhere for the general deposition of the dead of the Mound Builders."

Skeleton No. 374, a child about eight years of age, was also taken up to-day; position horizontal, head north.

January 21st, skeleton No. 375, an adult in horizontal position; length 5 feet 6 inches, depth 20 inches, head southeast, and directly under a large oak tree. On the 22d, four inches below this skeleton, another adult skeleton (376) was discovered in the same position and direction, with its head also under the tree. A small vessel was found near the right of the cranium, but so surrounded with roots as to necessitate its removal in pieces.

Skeleton No. 377 was that of a child about eight years of age, depth 20 inches; a mere heap of bones irregularly disposed, head southeast, face downward. A small stone flesher was found in the leaf mold near these remains.

On Saturday, January 24th, a small earthen vessel was found, unaccompanied by and about ten feet distant from any human remains.

An ash pit was also opened to-day, from which was taken out of the leaf mold, at a depth of 24 inches, three earthen vessels. Four inches west of the pit, the cranium of an adult male skeleton (No. 378) was uncovered; position horizontal, head east, length 5 feet 6 inches. Parallel to this was an adult female skeleton (No. 379) in the same position, head east, eight inches from the edge of the pit. At the side of the female lay the remains of an infant, probably two years of age.

The above mentioned vessels were undoubtedly deposited with this group of skeletons and do not properly belong to the relics found in ash pits in which no perfect vessel has yet been discovered.

Monday, January 26th, skeleton No. 381, an infant probably 4 years of age, was found about six feet northwest of the oak tree; these remains probably belong with the group exhumed on the 22d (Nos. 375–6).

January 27th, three skeletons were removed. No. 382 was an adult in horizontal position, head east, depth 18 inches, with the lower extremities extending under a large walnut stump. No. 383 an adult male in same position, at a depth of four feet; the length of this skeleton was five feet four inches. No. 384 was an adult female in horizontal position, head south, length 5 feet 4 inches, depth 4 feet 3 inches; the bones of the right leg and thigh were missing.

On Friday, January 30th, another skeleton (No. 386), an adult male, was found in same position, head south, length 5 feet 7 inches, depth 19 inches, completing this group of four skeletons, of which two lay with heads directed east and the other two with heads south; one pair were buried very deep, over four feet, and the other pair quite shallow, 18 and 19 inches.

January 29th, another group had been discovered, and skeleton No. 385 removed. This was an adult male in horizontal position, head east, length 5 feet 6 inches, depth 13 inches. A large vessel was deposited over the left hip, and a carapace of the common box tortoise, *Cestudo virginea*, at the left side of the neck.

On the 31st, three other skeletons belonging to this group were uncovered. No. 387, an adult male, position horizontal, head east, length 5 feet 8 inches, depth 20 inches. On the left of the chest of this skeleton was the complete shell of the *C. virginea*, with two perforations through plastron and carapace. This relic might be classed as a musical instrument or rattle. At the feet of this skeleton was an earthen vessel, and at the right shoulder, the cranium of skeleton No. 388, an adult irregularly disposed in a heap, with the remains of No. 389, an immature skeleton about 10 or 12 years of age, also irregularly disposed. No relics accompanied these two latter skeletons.

Monday, February 2d, No. 390, skeleton of an immature person, probably 12 years of age, was exhumed, position horizontal, head east, depth 20 inches. Skeleton No. 391, an adult male was discovered on February 6th, in horizontal position, head south, length 5 feet 10 inches, at a depth of 17 inches. A vessel was found at the left of the cranium. On February 7th, under a large walnut tree, skeleton No. 392 was found, and a few feet distant, beneath a large hackberry tree, two other skeletons (Nos. 393–4), with heads directed east, were seen, but no measurements could be obtained of any of these remains.

February 10th. On this date an excavation was begun, in what we supposed to be a hearth or irregular ash pit, but after sixty days' excavations of the same character, it was evident that the place was a kitchen-midden.

The location at the head of a ravine, the character of the deposits in irregular layers of ashes, charcoal, charred animal remains and other refuse, all confirmed this opinion. The leaf mold was of about the same depth as in other parts of the cemetery, and several skeletons were found within this space.

On Friday, February 17th, a group of five skeletons was found within the limits of the kitchen midden. Skeleton No. 395, an adult female in

horizontal position; head south, length 5 feet, depth 15 inches. A broken vessel, ornamented with a human face (see fig. 33), at the left side, and a perforated elkhorn relic, lying on the hip, were found with these remains.

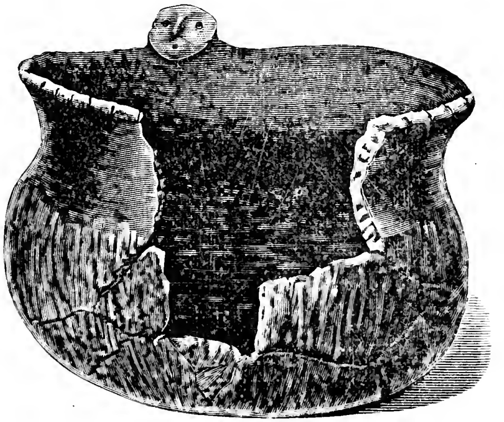

Fig. 33. Earthen Vessel. One third size.

Skeleton No. 396 was that of a child about four years of age, and No. 399 an immature skeleton about 10 years of age, was lying parallel, and about five feet distant; both were in horizontal positions, with heads directed south, and buried about 18 inches deep. A vessel was found at the right side of the cranium of one of these skeletons.

Skeletons Nos. 397–8 were adults, irregularly disposed, heads southeast. No measurements could be taken, as these remains were a mere heap of bones. Two vessels were found, one at the top of each cranium.

On Saturday, February 21st, another group of five skeletons was found just north of the kitchen-midden, disposed as follows: Skeleton No. 400, an adult female in horizontal position; head east, length 5 feet 4 inches, with a small vessel at the right side of the head. The next skeleton (No. 401) was an adult male, 5 feet 6 inches in length, in horizontal position, head south, depth 2 feet, with a large vessel at the left side of the head, and two large bone beads, one on each side of the neck, in such a position as to indicate that they had been suspended from the ears. This skeleton was lying at right angles with No. 400, and over the lower extremities of these two was found three crania of children, probably three, eight and twelve years of age; the remainder of their skeletons were irregularly disposed, and mingled with those of the adult skeletons.

On Wednesday, February 25th, a third group, consisting of one adult

male (No. 405) and three immature skeletons was found, all in horizontal positions, with heads east; a vessel lay at the top of the head of the adult skeleton.

No. 409 was an adult male; position horizontal, head southeast, length 5 feet 7 inches, depth 24 inches. About two feet distant No. 410 was found, also an adult male, 5 feet 8 inches in length, position horizontal, with head south. A vessel was found at the left of the cranium.

Thursday, February 26th, skeleton No. 411, immature, probably 12 years of age, was exhumed; position horizontal, head east, with vessel at top of the head.

Skeleton No. 412 was an adult male, 5 feet 7 inches in length, in horizontal position, head northeast, depth 25 inches.

On Friday, February 27th, a group of four skeletons (Nos. 413–16) was found, the remains of three adults and one infant, deposited in an irregular heap, depth 27 inches. A small, perfect vessel was found with the group.

Monday, March 1st, two adult male skeletons were uncovered. No. 417 lay in horizontal position, head northwest, length 5 feet 6 inches, depth 20 inches. No. 418 in same position, with head directed west, length 5 feet 2 inches, depth 18 inches.

March 2d, two skeletons were found in the kitchen-midden. No. 419 was an adult male, in horizontal position, head east, length 5 feet 4 inches, depth 12 inches. About six feet west of these remains, the skeleton of a child (No. 420), with head directed south, was found at a depth of 21 inches.

Skeleton No. 421 was found on Friday, March 5th, about seven feet north of the kitchen-midden. This was an adult female, 4 feet 5 inches in length; position horizontal, head east, depth 20 inches. A broken vessel at the right side.

Near the lower extremities, between this skeleton and the edge of the kitchen-midden, four ash pits were found, from which a number of fine relics were taken, and among other things, a quantity of charred corn-cobs.

On Monday, March 8th, five skeletons were exhumed (Nos. 422–26) one adult and four children, all in horizontal position, and about 20 inches deep.

Two children, probable age six years, lay with their heads to the west; immediately west of these remains was an adult male with head south, and two feet further west were two other children, with heads south.

From this date until April 1st, the work of excavation was continued in the kitchen midden, and having reached the head of the ravine, on

the western edge of the plateau, it was deemed advisable to abandon further exploration in this direction. A cross section at this point shows a horizontal line 34½ feet long, and a depth of seven feet in the center, gradually sloping to the surface on both sides. The leaf mold and clay was about 18 inches deep, and below this were three irregular layers and deposits of ashes, varying from a few inches to 1½ feet in thickness; large quantities of shells, animal remains, charred wood, etc., were scattered through these layers. Several pipes, two grooved stone hammers, a roll of copper three inches in length, and a number of other relics were found during the excavation of this kitchen-midden.

March 18th, an adult female skeleton (No. 427) was found just outside the limits of the kitchen-midden, in horizontal position, head southeast, length 5 feet 3 inches, at a depth of 14 inches.

On April 2d, an excavation was commenced on the slope east of the plateau, and continued until the 6th. This part of the cemetery was found to be of the same character (kitchen-midden), and composed of ashes, animal remains and refuse, although not so extensive as that on the western slope. Several relics and a small roll of copper were obtained, but no human remains were found.

On Wednesday, April 9th, two ash pits were opened. In one of these pits a layer or deposit of charred maize leaves and stalks, about one inch thick, was above the layer of ashes.

Four skeletons were also exhumed to-day. No. 428 was an adult male, in horizontal position, head south, length 5 feet 3 inches. A broken vessel at the right side of the head. Nos. 429 and 430 were also adult male skeletons, in horizontal positions, heads south, and both measured 5 feet 6 inches in length. Skeleton No. 431 was incomplete, with trunk lying south; the cranium, cervical vertebræ and bones of the arms and hands were wanting; depth 14 inches.

April 8th, skeleton No. 432, immature, probably 15 years of age, in horizontal position, head south, depth 15 inches. A grooved stone hammer was found in the leaf mold, near these remains.

April 10th, two ash pits were opened. In one of these pits a fine roll of copper and a number of fine relics were found.

Skeleton No. 433 was also exhumed to-day; position horizontal, head south, length 5 feet 6 inches, depth 11 inches. A broken vessel at the right of the cranium.

Dr. H. H. Hill, with several members of the Society, visited the cemetery to-day, and while excavating in the kitchen-midden on the western slope, near the southwest corner, discovered, at a depth of 14 inches, an adult female skeleton (No. 434), in horizontal position, head

south, length 5 feet 4 inches. Over these remains a layer of Unio shells had been carefully placed, completely covering the head and upper portion of the trunk of the skeleton.

On April 12th, an ash pit was opened, from which was taken, in addition to the flint and bone relics usually found, two pieces of copper, and on the bottom of the pit, in one corner, there was a deposit of carbonized maize leaves and stalks about six inches deep.

Skeleton No. 435, an adult male, was also exhumed; position horizontal, head south, depth 14 inches.

April 13th, skeleton No. 436, a child, probably three years of age, in horizontal position, head east. A few fragments of a vessel were found near the head. An ash pit was also opened, from which was taken a limestone pipe of peculiar form. (See fig. 34.)

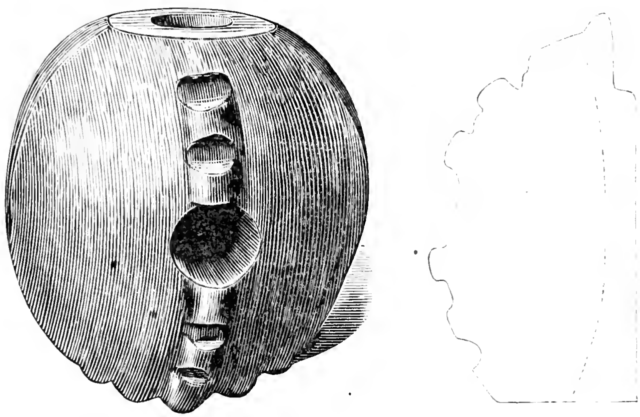

Fig. 34. Limestone Pipe. Front and Side Views.

On April 14th, skeleton No. 437, an adult male, was exhumed; position horizontal, head south, length 5 feet 7 inches, depth 18 inches.

Another skeleton (No. 438) was found to-day, lying directly under a small oak tree. These remains were very much decayed, and no measurements could be obtained.

Two skeletons of children (Nos. 439–40) were removed on April 15th, probable age two to four years, both in horizontal positions, heads east, and were buried at a depth of fifteen and twenty inches, respectively.

On April 17th, skeleton No. 441 was discovered among the roots, under a large oak, but could not be removed nor measurements made.

During the next few days, ten ash pits were discovered and explored, and a number of relics were found, among other things, a rude

vessel made of clay, moulded with the hands, apparently a toy, as it is too small for any useful purpose.

April 23d, skeleton No. 442, an adult female, 5 feet in length, was found, in horizontal position, head south and hands folded over the pelvis; depth 12 inches. A large vessel was found between the knees.

Saturday, April 24th, three skeletons were exhumed. No. 443 was an adult female, in horizontal position, head east, length 5 feet 4 inches. No. 444, a small child of about two years of age, was lying at the right of the preceding skeleton, with the cranium underneath the right ilium. Skeleton No. 445 was that of an adult male, also in horizontal position, head north, length 5 feet 5 inches. A vessel was found at the left of the cranium. These burials were remarkably shallow—not more than ten or twelve inches deep.

Skeletons Nos. 446–7 were children, probably two and six years of age, in horizontal position, at a depth of 20 inches, and were very much decayed. Several ash pits were next opened, one of which was directly under the oak tree and opposite to skeleton No. 441, discovered on the 17th.

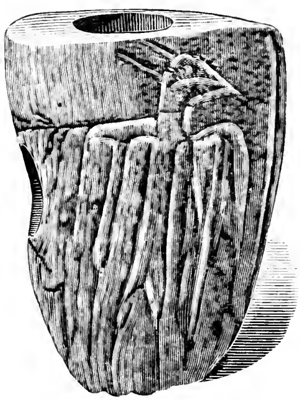

Fig. 35. Sandstone Pipe.

On April 29th, skeleton No. 448, an adult male, position horizontal, head southeast, depth 17 inches, was found lying over one of the ash pits. The bones of the forearm, lumbar vertebræ, pelvic bones and the two femora were missing. A careful examination was made, but none of the missing bones could be found in the ash pit. A small vessel was taken from near the cranium, on the right side.

Saturday, May 1st, skeleton No. 449, a child about three years of age, was exhumed; position horizontal, head north. A small vessel was found near the top of the head.

A small sandstone pipe was picked up on the surface, about 50 feet distant from the excavation. This relic (see fig. 35) is ornamented with rude carvings, representing a bird with outstretched wings (spread eagle style), and had been rooted up by the hogs which had been turned into the woods. The avidity with which these animals devoured the fragments of bones scattered about the excavation was remarkable, and it required constant watchfulness on the part of the workman to prevent them from rooting up and destroying the skeletons while being exhumed.

May 4th, skeleton No. 450 was that of a child about three years of age, in horizontal position, head southeast, depth 15 inches, with a vessel at the left hip. An adult female skeleton (No. 451) was also exhumed to-day, position horizontal, head southeast, with the hands folded over the pelvis. A small grooved hammer was found behind the cranium.

An immature skeleton (No. 452) was found on May 5th, in the same position as the two preceding, and belonging to the same group. Probable age 14 years.

May 7th, two skeletons were exhumed. No. 453 was an adult female, 5 feet 4 inches in length, in horizontal position, head east, depth 15 inches. A small vessel was found at the right side of the head. At the right side of this skeleton was that of a child not over two years of age, and with these remains a perforated shell ornament and a shell bead were found. (See fig. 36.)

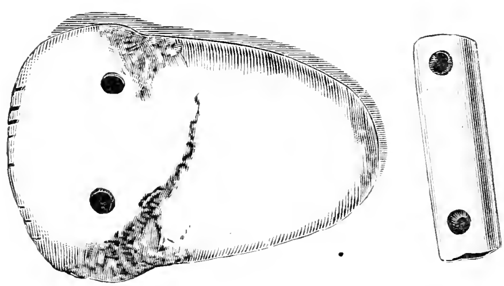

Fig. 36. Shell Ornament and Bead.

Eight ash pits were explored during the week, several of which contained layers of white sand between the deposits of ashes.

Monday, May 10th, skeleton No. 455, an adult male, 5 feet 7 inches in length; position horizontal, head northeast, depth 20 inches. A vessel of about one quart capacity was found near the head, on the ight side, and near the left hip, a small stone flesher or skin dresser.

Another pipe was found on the surface to-day. (See fig. 37.)

May 12th to 14th, several ash pits were opened, which differed from any heretofore explored, each having a circular excavation in the bottom about 10 inches in diameter and from 6 to 9 inches in depth. These depressions were directly in the center of each pit, and were filled with a pure white ashes, and were covered with a layer of burnt limestone or boulders. It is also remarked that these pits contained a

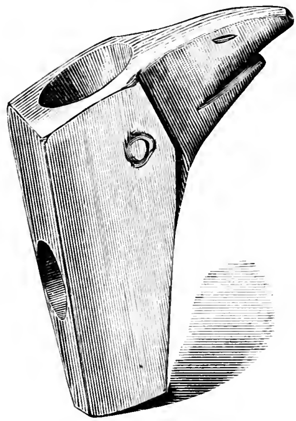

Fig. 37. Limestone Pipe.

greater number of implements and relics than others recently opened.

Skeleton No. 456 was exhumed on the 14th, an adult female, in horizontal position, head northwest, depth 16 inches.

Rev. Stephen Bowers, of Kansas, a well-known archæologist, and Dr. H. H. Hill visited the grounds, and spent the day in excavating and examining the relics exhumed. Mr. Bowers' opinion that there are many indications of a high antiquity for these remains, and that the ash pits may have been temporary burial places, is entitled to great weight, and coincides with the writer's views as expressed on a previous page.

May 15th, skeleton No. 457, an adult female, 5 feet 3 inches in length, was exhumed; position horizontal, head east, depth 22 inches. Skeleton No. 458 was also an adult female, in same position, head south, length 4 feet 10 inches, depth 24 inches. A small vessel was taken from near the top of the cranium.

Parallel with this skeleton, and one foot ten inches west, lay skeleton No. 459, an adult male, length 5 feet 8 inches, depth 14 inches. At the left side of the head was found the fragments of a very large vessel.

Monday, May 17th, an adult male skeleton (No. 460) was found, in horizontal position, head south, length 5 feet 8 inches, depth 19 inches.

Skeleton No. 461 was an adult female, 5 feet 2 inches in length, also in horizontal position, with head directed south. At the feet of this skeleton a vessel was found.

Skeleton No. 462 was immature, probably 15 years of age, in horizontal position, head southeast, and was found immediately under the preceding skeleton, at a depth of 24 inches. Two shell ornaments were taken from near the neck.

Tuesday, May 18th, a group of six skeletons was discovered disposed in a very singular manner. No. 463 was an adult female, in horizontal position, head south, with hands folded over pelvis; length 5 feet, depth 28 inches. A vessel at the right side of the head. Immediately under this skeleton, at a depth of 40 inches, was skeleton No. 464, an adult male, 5 feet 6 inches in length, in horizontal position, head north. A small stone pipe was found among the bones of the right hand. Just east of the above skeleton, at the same depth, the skeletons of four children, ranging from four to six years of age, were found; two of these skeletons lay with feet close together, near the humerus of the adult skeleton, with the head of one directed northeast and the other southeast. The other pair lay with feet close to the tibia of the adult, one with head east, and the other with head directed southeast. The earth above these remains was baked hard, and in several places of a brick-red color; the leaf mold over this group was but six inches in depth, while on either side of the excavation this layer measured 16 inches.

On Thursday, May 20th, another ash pit, with the circular excavation in the bottom, was explored; diameter 3 feet 8 inches, depth 6 feet 5 inches, exclusive of the depression. The first layer of leaf mold and sand was 27 inches, next 30 inches of ashes and sand, containing the usual animal remains, shells, etc.; the third layer was about 11 inches of yellow sand. The circular excavation was 9 inches deep, and filled with pure white ashes, and covered with a thin layer of burnt limestones.

On Saturday, May 22d, an ash pit was discovered under a large mulberry tree, and could not be explored. Four skeletons were also exhumed. No. 469, immature, probably 6 years of age, in horizontal position, head south, depth 26 inches. Skeleton No. 470, an adult male, in a doubled up position, head north, depth 22 inches. No. 471 was an adult female, 5 feet in length, in horizontal position, head north, depth 28 inches, with a vessel at the right of the cranium. Directly

under this skeleton was No. 472, an adult male, 5 feet 6 inches in length, in same position. The occiput of the upper skeleton rested in a broken vessel, which undoubtedly had been crushed between the two skulls. The fragments of this vessel (see fig. 38) were all gathered, and

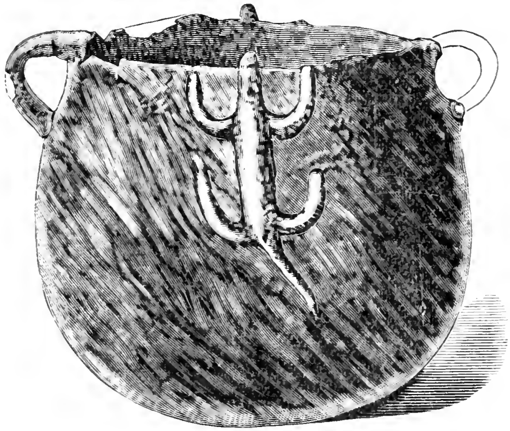

Fig. 38. Vessel with Salamander Ornamentation. One third size.

it has since been restored. The Salamander-like ornamentation of this vessel is entirely new and peculiar to this cemetery. Several fragments and handles of vessels have been found, representing four or five species of the *Salamandridæ* or other *Urodela.*

Monday, May 24th, an ash pit was explored, and four skeletons discovered. No. 473, an adult female, 5 feet 3 inches in length, position horizontal, head east, depth 23 inches. No. 474, an adult male, 5 feet 5 inches in length, in same position and direction, depth 24 inches. A vessel was found at the left of the cranium.

Skeleton No. 475, also an adult male, in horizontal position, head east, depth, 22 inches. A broken vessel also at the left of the head. No. 476 was the skeleton of a small child, not over two years of age, lying parallel with the preceding skeleton. With these remains a small strip of copper was found lying on the chest.

On Tuesday, May 25th, seven skeletons, of which five were children and two adults, were exhumed. Skeleton No. 477, a child, probably 3 years of age, in horizontal position, head northeast, depth 32 inches; vessel at top of the head.

Skeleton No. 478 was another child of about the same age, with head south, depth 26 inches; vessel at the right of the head. No. 479, an adult female, 5 feet 3 inches in length, in horizontal position, head south, depth 29 inches; a broken vessel at the right of the head.

Skeleton No. 480 was a very small child, lying parallel with the head of the preceding skeleton. No. 481, a child, about two years of age, lying parallel with the femur of the adult female. An inverted broken vessel was found with these remains.

Skeleton No. 482 was also an adult female, 4 feet 6 inches in length, in horizontal position, head south, depth 14 inches: a broken vessel at the right of the head. Lying along the inside of the right leg of this skeleton was the remains of an infant, not exceeding one year old.

May 26th, skeleton No. 484 was an adult male, 5 feet 6 inches in length, in horizontal position, head south, depth 25 inches; a vessel at the left side of the head. Skeleton No. 485, an adult female, in horizontal position, head east, depth 21 inches, and overlying the lower extremities of the preceding skeleton.

No. 486 was also an adult female, in horizontal position, head south, depth 19 inches.

May 28th, the skeleton of a child (No. 487) was exhumed; position horizontal, head south, depth 19 inches. A broken vessel at the left of the cranium.

Monday, May 31st, three skeletons exhumed. No. 488 was an adult female, 5 feet 5 inches in length, in horizontal position, head south, depth 25 inches; vessel at the right of the cranium. Lying along the right arm, the remains of a child, about two years of age, were found. Skeleton No. 490 was an adult male, 5 feet 4 inches in length, in horizontal position, head east, lying with the hips over the lower extremities of No. 488; the left hand was placed over the pelvis, while the other arm was parallel with the trunk. A perfect vessel was found at the right of the head, and fragments of another were at the left side.

Skeleton No. 491 was discovered on Tuesday, June 1st, an adult female, 4 feet 11 inches in length; position horizontal, head east, depth 21 inches. Vessel at the right of the head. No. 492 was a child, probably 4 years of age, lying parallel with the above, at a depth of 19 inches.

June 2d, No. 493, a small child; bones so much decayed that neither length nor position could be satisfactorily determined. A vessel and three deerhorn arrow-flakers were found with these remains.

June 4th, three skeletons exhumed. No. 494 was an adult female, 4 feet 7 inches in length, in horizontal position, head north, depth 12 inches. With these remains was found two bone beads at the neck, and along the spinal column, extending to the lower extremities, and on the chest, a large number of copper beads; sixty-seven were picked up at first, and on further search about the skeleton and in the earth

thrown out of the excavation, twenty-one others were found, making eighty-eight in all. Most of these beads were of the usual form, mere rolls of copper, while others were formed from strips of copper about two inches in length, rolled spirally, or twisted into a wire and made into a spiral, spring-shaped bead.

A small, perfect vessel, with Salamander ornamentation, was found near the lower extremities (see fig. 39), and about a handful of charred

Fig. 39. Vessel with Salamander Handles. One third size.

corn was found near the cranium. No. 495 was an adult male, 5 feet 4 inches in length, in same position, and lying directly under the above skeleton, at a depth of 15 inches. Skeleton No. 496, an adult female, length 4 feet 9 inches, in horizontal position, head south, depth 11 inches, was found about two feet west of the above.

On Monday, June 7th, another ash pit, with the circular excavation, was explored, from which two rolls of copper, five bone beads, one ungrooved ax, a stone skin-dresser, a sandstone pipe (see fig. 40), several bone relics, and an unusual quantity of animal remains, shells, etc., were taken.

June 8th, skeleton No. 497, the remains of a child about three years of age, was lying in horizontal position, head southwest, depth 16 inches.

From this date to June 17th, nothing but ash pits were discovered; nine were opened and examined. A number of stone and bone relics of copper, and two pipes, were the results obtained from these pits.

On June 17th, two skeletons were exhumed. No. 498 was a child, probably three years of age, in horizontal position, head south, depth 18 inches. No. 499, an adult female, 5 feet 3 inches in length, also in horizontal position, head south, depth 20 inches.

Skeleton No. 500 was taken out on June 18th, and was the remains of an adult female, in horizontal position, head south, length 4 feet 10 inches; the right hand was placed over the pelvic bones, and the left at the side parallel with the body.

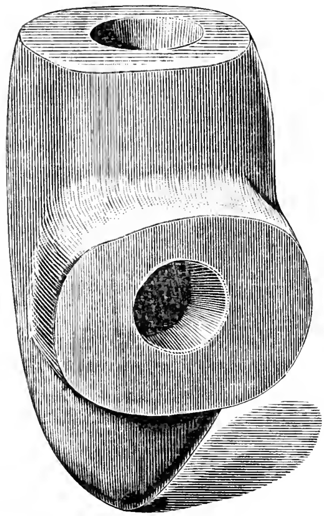

Fig. 40. Sandstone Pipe.

June 19th, an ash pit was opened, from which was taken a large semi-circular piece of copper about 1 inch wide, $\frac{3}{8}$ thick, and $3\frac{1}{2}$ inches in diameter, through which a large root, five inches in circumference, had grown. The copper was so imbedded and overgrown that it could not be removed until after the root became dry and shrunken. It has the appearance of native Lake Superior ore, roughly hammered into its present shape.

Monday, July 21st, skeleton No. 501, a child about three years of age, in horizontal position, head south, was found, at a depth of 16 inches.

June 23d, an adult female skeleton (No. 502) was exhumed, length 5 feet, position horizontal, head south; lying on the left side, facing west, both hands folded over the pelvis, depth 21 inches.

From this date to June 30th, another series of ash pits was discovered, and eight opened. The usual relics and remains were found.

The great quantity of copper found during the excavations of the past few weeks is very remarkable, more than one hundred pieces having been obtained.

The interest taken in our explorations by the members, and the pecuniary assistance rendered by an appropriation from the funds of the Cincinnati Society of Natural History, has enabled the Madisonville Society to prosecute the work of excavation as rapidly as desirable. It has also resulted in placing in the Museum of the Cincinnati Society a fine collection of the crania from this cemetery, and one of the most complete series of prehistoric remains ever obtained from any one locality.

SUMMER BIRDS OF A NORTHERN OHIO MARSH.

By Frank W. Langdon.

The birds mentioned in the following list were, with a few exceptions, elsewhere noted, observed by the writer in company with Mr. J. B. Porter of Glendale, Ohio, on the grounds of the Wynou's Point Shooting Club, near Port Clinton, Ottawa county, Ohio, during the week ending July 4, 1880.

This locality, comprising some nine or ten thousand acres of marsh, situated at the head of Sandusky Bay, and overgrown with flags, bulrushes, cane-grass, water-lilies and other characteristic aquatic vegetation, is doubtless a summer resort for nearly all species of "water" birds which breed in the State, and several species were probably overlooked owing to the limited period of time at our disposal.

At the time mentioned, however, nearly all the water birds observed were breeding, the eggs taken being mainly, if not entirely, those of the second brood, as we ascertained from a resident who had taken the eggs of the Coot, Florida Gallinule and Black Tern a full month previous; and as was indicated by the fact that at the time of our visit the first brood of the Swamp Blackbird, Long-billed Marsh Wren, Black Tern and White-bellied Swallow were observed on the wing.

As little or nothing has heretofore been published regarding the breeding habits and localities of water-birds in Ohio, it is hoped that the observations herein recorded may be an acceptable contribution to the subject.

In order to complete the list of the summer birds of the locality as far as practicable, a list is also given of the "land" birds observed on the borders of the marsh; several species are included on the authority of Mr. J. B. Porter, he having observed them during this or previous summers.

The absence from the list of such species as the Tufted Titmouse, Great Carolina Wren, Yellow-breasted Chat, Redstart, and our two Tanagers, is noticeable in view of their comparative abundance in Southern Ohio; but in some cases of course this absence may only indicate failure of observation, owing to comparative rarity of the species at the locality under consideration.

The thanks of the writer are due to the above-mentioned Club for various privileges accorded during his stay; to Mr. J. H. Porter for the use of boats and other conveniences, and to Mr. J. B. Porter, whose knowledge of the locality and of its birds was an invaluable aid in our observations and collections.

For the nomenclature, such standard works as Dr. Coues' "Key to North American Birds," and "Birds of the Colorado Valley," and Baird, Brewer & Ridgway's "History of North American Birds," have been consulted. Some recent changes have been adopted from the current ornithological literature, notably that contained in the "Bulletin of the Nuttall Ornithological Club."

LAND BIRDS.

Order PASSERES: PERCHERS.
Sub-order OSCINES: SINGING PERCHERS.

Family TURDIDÆ: *The Thrushes.*

1. TURDUS MUSTELINUS, Gmelin.—*Wood Thrush.*—A few observed in the groves bordering the marsh.

2. TURDUS MIGRATORIUS, Linnæus.—*Robin.*—Common.

3. HARPORHYNCHUS RUFUS, Cabanis.—*Brown Thrasher.*—Rather common.

4. GALEOSCOPTES CAROLINENSIS, Cabanis.—*Catbird.*

Family SAXICOLIDÆ: *Bluebirds; Stonechats.*

5. SIALIA SIALIS, Baird.—*Eastern Bluebird.*

Family SYLVIIDÆ: *Sylvias.*

6. POLIOPTILA CÆRULEA, Sclater.—*Blue-gray Gnatcatcher.*—Evidently this species is here much less common than in Southern Ohio, as our only identification of it rests on the note of a single individual heard.

Family PARIDÆ: *Titmice.*

7. PARUS CAROLINENSIS, Audubon.—*Carolina Chicadee.* (*Porter.*)

8. SITTA CAROLINENSIS, Latham.—*White-bellied Nuthatch.*

Family Troglodytidæ: *Wrens.*

9. Troglodytes domesticus, Coues.—*House Wren.*—Breeds. (*Porter.*)

10. Telmatodytes palustris, Baird.—*Long-billed Marsh Wren.*—An abundant species, its lively, grasshopper-like notes resounding on all sides in the marsh. The nests, which are more or less globular or ovoid in shape, are neatly constructed of saw-grass, dried moss and bulrushes, and suspended from one to three feet above the water in a clump of flags or saw-grass. The entrance is at one side, and well concealed from view in the occupied nests. Five eggs appear to constitute a full set, although we took sets of four that were slightly incubated; and while most of those taken were fresh, or nearly so, a few sets were far advanced in incubation. (July 2d.)

Many empty nests of this species were found, at least two or three nests being observed to each pair of birds. In many cases the conspicuous situation of these supernumary nests, and the well concealed one of the occupied nest near by, would seem to favor the supposition that the empty structures were decoy nests, built to deceive enemies; as the Wrens appear to be seldom disturbed however, this hypothesis can hardly be entertained. It seems more likely that they may be intended for lodging-places for the males and the first brood of young, or else are simply the result of that intense over-activity which seems to characterize the whole Wren family, and shows itself in our Carolina and House Wrens by their habit of almost invariably *filling* the cavity in which they nest, no matter how large it may be.

We noticed a marked difference in compactness of structure between the supernumary and the occupied nests, the former being invariably water-soaked after a hard rain, while the latter remained perfectly dry to the touch inside.

Family Sylvicolidæ: *American Warblers.*

11. Dendrœca æstiva, Baird.—*Yellow Warbler.*—A very common species in the willows bordering the marsh; young of the first brood observed on the wing.

12. Siurus nævius, Coues.—*Small-billed Water Thrush.*—One specimen only observed; so close that there could be no question as to its identity.

13. Geothlypis trichas, Cabanis.—*Maryland Yellow-throat.*—Rather common, though not so abundant as would be expected considering the adaptation of the locality to its habits.

Family Hirundinidæ: *Swallows.*

14. Progne subis, Baird.—*Purple Martin.*

15. Petrochelidon lunifrons, Cabanis.—*Cliff Swallow.*—Many observed carrying mud ; doubtless to repair their nests for the reception of the second brood.

16. Hirundo erythrogastra, Boddaert.—*Barn Swallow.*—Much less common than the succeeding species. First brood on the wing.

17. Tachycineta bicolor, Cabanis.—*White-bellied Swallow.*—An abundant species ; the prevailing Swallow of the locality. Numerous young of the first brood observed on the wing in their peculiar silvery drab first plumage. On June 29th, a nest containing one addled egg and a young bird (probably of the second brood), was observed in a knot hole in an old snag, about two feet above the water ; with the exception of a thin layer of water moss and grass as a foundation, this nest was composed entirely of feathers, amongst which could be recognized those of tame geese, chickens, wild ducks, and the Great Blue Heron.

18. Cotyle riparia, Boie.—*Bank Swallow.*—A few only observed.

Family Vireonidæ: *Greenlets.*

19. Vireo olivaceus, Vieillot.—*Red-eyed Vireo.*—Much less numerous than in southwestern Ohio, being evidently replaced to a great extent by the Warbling Vireo which was exceedingly common.

20. Vireo gilvus, Bonaparte.—*Warbling Vireo.*—As above stated this species was found in considerable numbers, the woods and scattered groves on the borders of the marsh resounding with their musical and somewhat plaintive notes.

Family Ampelidæ: *Waxwings.*

21. Ampelis cedrorum, Sclater.—*Cedar Waxwing.*—Observed breeding in 1878, by Mr. J. B. Porter.

Family Laniidæ: *Shrikes.*

22. Lanius ludovicianus excubitoroides, Coues.—*White-rumped Shrike.*—A single pair observed.

Family Fringillidæ: *Finches, Sparrows, etc.*

23. Chrysomitris tristis, Bonaparte.—*American Goldfinch; Thistle Bird.*

24. Passer domesticus, Linnæus.—*European House Sparrow.*—Common at Port Clinton, within five or six miles of the marsh.

25. POOCÆTES GRAMINEUS, Baird.—*Bay-winged Bunting; Grass Finch.*

26. SPIZELLA PUSILLA, Bonaparte.—*Field Sparrow.*—Summer resident. (*Porter*).

27. SPIZELLA SOCIALIS, Bonaparte.—*Chipping Sparrow.*—Common.

28. MELOSPIZA MELODIA, Baird.—*Song Sparrow.*—Common.

29. EUSPIZA AMERICANA, Bonaparte.—*Black throated Bunting.*—Three or four specimens observed and taken.

30. CYANOSPIZA CYANEA, Baird.—*Indigo Bird.*—Very common.

31. CARDINALIS VIRGINIANUS, Bonaparte.—*Cardinal Redbird.*—Not common; only two or three individuals observed.

32. PIPILO ERYTHROPHTHALMUS, Vieillot.—*Towhee Finch; Ground Robin.* (*Porter.*)

Family ICTERIDÆ: *Orioles.*

33. DOLICHONYX ORYZIVORUS, Swainson.—*Bobolink.*—A few specimens only observed.

34. MOLOTHRUS ATER, Gray.—*Cowbird.*—Common.

35. AGELAIUS PHŒNICEUS, Vieillot.—*Swamp Blackbird; Red-Shouldered Blackbird.*—As would be expected the Red-wings were abundant in the marsh, rising before us at every few yards from their nests, which are usually situated in the "sawgrass" or flags, within a foot or thereabouts of the water. At the time of our visit the young of the first brood were on the wing, and the second set of eggs had evidently not yet been completed in most cases, as most of the nests observed contained but two or three eggs, which were quite fresh.

36. STURNELLA MAGNA, Swainson.—*Meadow Lark.*—Common.

37. ICTERUS SPURIUS, Bonaparte.—*Orchard Oriole.*—Common.

38. ICTERUS BALTIMORE, Daudin.—*Baltimore Oriole.*—Common.

39. QUISCALUS PURPUREUS ÆNEUS, Ridgway.—*Bronzed Grakle.*—The several Crow Blackbirds shot, proved on inspection to be of this form.

Family CORVIDÆ: *Crows, Jays, etc.*

40. CORVUS AMERICANUS, Audubon.—*Common Crow.*

Sub-order CLAMATORES: NON-MELODIOUS PASSERES.

Family TYRANNIDÆ: *Tyrant Flycatchers.*

41. TYRANNUS CAROLINENSIS, Baird.—*Kingbird.*—In the woods and groves bordering the marsh we met with this species in greater numbers than I have ever seen it elsewhere; they were not in flocks, but in some places almost every tree appeared to be occupied by a pair of

these vociferous insect-collectors. The abundance of the "deer fly" and other insect pests about the marsh at this season is such that the Kingbird is an exceedingly welcome addition to the fauna.

42. MYIARCHUS CRINITUS, Cabanis. — *Great-crested Flycatcher.* (*Porter.*)

43. SAYORNIS FUSCUS, Baird.—*Pewee.*—In spite of the abundance of insect food we observed but a few of this species.

44. CONTOPUS VIRENS, Cabanis.—*Wood Pewee.*—Common.

45. EMPIDONAX MINIMUS, Baird.—*Least Flycatcher.*—One specimen taken.

Order PICARIÆ: PICARIAN AND SYNDACTYLE BIRDS.

Family ALCEDINIDÆ: *Kingfishers.*

46. CERYLE ALCYON, Boie.—*Belted Kingfisher.*—Common.

Family CYPSELIDÆ: *Swifts.*

47. CHÆTURA PELAGICA, Baird.—*Chimney Swift.*

Family CUCULIDÆ: *Cuckoos.*

48. COCCYGUS AMERICANUS, Bonaparte.—*Yellow-billed Cuckoo.*—(*Porter.*)

Family PICIDÆ: *Woodpeckers.*

49. PICUS PUBESCENS, Linnæus.—*Downy Woodpecker.*

50. MELANERPES ERYTHROCEPHALUS, Swainson.—*Red headed Woodpecker.*—Common.

51. COLAPTES AURATUS, Swainson.—*Flicker; Golden-winged Woodpecker.*

Order RAPTORES: OWLS, HAWKS AND VULTURES.

Family STRIGIDÆ: *Owls.*

52. SCOPS ASIO, Bonaparte.—*Mottled Owl; Screech Owl.*—Two specimens, young of the year, taken; both were in the gray "phase" or plumage.

Family FALCONIDÆ: *Falcons.*

53. FALCO SPARVERIUS, Linnæus.—*Sparrow Hawk.*

54. NISUS FUSCUS, Kaup.—*Sharp-shinned Hawk.*—May, 1877. (*Porter.*)

55. NISUS COOPERI, Bonaparte.—*Cooper's Hawk.*—May, 1877. (*Porter.*)

56. BUTEO BOREALIS, Vieillot.—*Red-tailed Hawk.* (*Porter.*)

57. Haliaetus leucocephalus, Savigny.—*American or White-headed Eagle.*—Several specimens observed during our stay, flapping lazily over the marsh or taking a siesta on some projecting snag. A nest of this species which came under, or rather over our observation, appeared to be a globular mass of branches, twigs and cornstalks, about four or five feet in diameter, and was situated in an upright fork of an elm, about seventy-five feet from the ground. We were informed that it had been occupied the previous year.

Family Cathartidæ: *American Vultures.*

58. Cathartes aura, Illiger.—*Turkey Vulture or Buzzard.*—(*Porter.*)

Order Columbæ: Columbine Birds.

Family Columbidæ: *Pigeons.*

59. Zenædura carolinensis, Bonaparte.—*Carolina Turtle Dove.*—Nest containing half-fledged young observed July 2d.

Order Gallinæ: Gallinaceus Birds.

Family Meleagridæ: *Turkeys.*

60. Meleagris gallopavo, Linnæus.—*Wild Turkey.*—Rare. (*Porter.*)

Family Tetraonidæ: *Grouse.*

61. Bonasa umbellus, Stephens.—*Ruffed Grouse.*—Rare. (*Porter.*)

Family Perdicidæ: *Partridges.*

62. Ortyx virginianus, Bonaparte.—*Quail.*

WATER BIRDS.

Order Limicolæ: Shore Birds.

Family Charadriidæ: *Plover.*

63. Ægialitis vocifera, Bonaparte.—*Killdeer Plover.*—Breeds. (*Porter.*)

Family Scolopacidæ: *Snipe.*

64. Philohela minor, Gray.—*American Woodcock.*

65. Gallinago wilsonii, Bonaparte.—*Wilson's Snipe; Jack Snipe.* Several shot in July, 1878. (*Porter.*)

66. Tringa minutilla, Vieillot.—*Least Sandpiper.* (*Porter.*)

67. TOTANUS MELANOLEUCUS, Vieillot.—*Greater Yellow-legs.*—July, 1879. (*Porter.*)

68. TOTANUS FLAVIPES, Vieillot.—*Lesser Yellow-legs.* (*Porter.*)

69. TOTANUS SOLITARIUS, Audubon. — *Solitary Sandpiper.*—July, 1879–80. (*Porter.*)

70. TRINGOIDES MACULARIUS, Gray.—*Spotted Sandpiper.*—Common.

Order HERODIONES: HERONS, IBISES, ETC.

Family ARDEIDÆ: *Herons.*

71. ARDEA HERODIAS, Linnæus.—*Great Blue Heron.*—Very common, and as shy as usual.

72. HERODIAS EGRETTA, Gray.—*Great White Egret.*—Usually common in August and September. (*Porter.*)

73. BUTORIDES VIRESCENS, Linnæus.—*Green Heron.*—Breeds. (*Porter.*

74. BOTAURUS MINOR, Boie.—*American Bittern.*—A few specimens only observed. Breeds. (*Porter.*)

75. ARDETTA EXILIS, Gray.— *Least Bittern.*— Quite common, frequenting and nesting amongst the "deer-tongue" and "saw-grass," at a considerable distance from land. Judging from the depth of water in situations where they were most numerous, we inferred that they spend much of their time clinging to the tall aquatic grasses, and walking about on the lily "pads" in search of food. They uttered no sound when flushed, and flew as noiselessly as owls. The nest is a rather bulky affair for the size of the bird, composed entirely of "saw-grass," a platform being constructed by bending a number of green blades toward a common center so that they cross each other at a height of fifteen or twenty inches from the water; this platform is slightly depressed in the center, and the depression lined with a few blades of dried grass of the same species as that used in the foundation. Four eggs, of a very faint greenish-blue tint and rounded oval in shape, constitute a full set; those taken were incomplete, containing from two to three eggs, which were fresh and probably the second laying of the season. They evidently build an entirely new nest for the second brood, as the grass was still fresh and green in those observed.

Order ALECTOROIDES: CRANES, RAILS, ETC.

Family RALLIDÆ: *Rails.*

76. RALLUS ELEGANS, Audubon.—*King Rail; Fresh-water Marsh Hen.*—One specimen taken by Mr. Porter, July 3d.

77. PORZANA CAROLINA, Cabanis.—*Sora Rail.* (*Porter.*)

78. Gallinula galeata, Bonaparte.—*Florida Gallinule.*—A very common species, breeding abundantly in the more open portions of the marsh. The nests are situated amongst the "saw-grass," and constructed of its dried blades. Their height varies, some almost resting on the water, while others are placed a foot or more above it and have an incline eight or ten inches in width, made of dried grass, extending from the nest to the water's edge, which makes them a conspicuous object where the surrounding vegetation is not too dense. The dozen or so sets of eggs taken were in various stages of incubation, and a few young were observed following their parents. The young, when a day or two old, are about the size of a newly-hatched domestic chicken, and when found in the open water are easily captured; they present a curious sight paddling for dear life, with their bright red and orange bills standing out in strong contrast with their sooty-black, down-covered bodies.

79. Fulica americana, Gmelin.—*Coot; Mud Hen.*—A few only observed, although we were informed that they are numbered by thousands in the early fall. A nest containing two fresh eggs on June 29th, was situated about six inches above the water, and constructed of the same material (dried saw-grass) as the Gallinule nests, but was rather flatter and considerably larger.

Order Lamellirostres: Geese, Ducks, etc.

Family Anatidæ: *Swan, Geese and Ducks.*

80. Branta canadensis, Gray.—*Common Wild Goose; Canada Goose.*—Mr. Porter informs me that individuals of this species are frequently seen in the marsh in summer, having probably been crippled during the shooting season and thereby prevented from migrating.

81. Anas boschas, Linnæus.—*Mallard Duck.*—Breeds. (*Porter.*)

82. Querquedula discors, Stephens.—*Blue-winged Teal.*—Breeds; eggs taken in June. (*Porter.*)

83. Fuligula affinis, Eyton.—*Lesser Scaup Duck.*—Small flocks observed daily during our stay. One individual, in a helpless condition, floated up to the dock, and was brought ashore by a retriever very gently, but died in a few hours, although no marks of shot or violence were discoverable on careful search *post-mortem.* Its stomach contained a few ants and other insects, and some young shells of a species of *Sphærium.*

84. Fuligula ferina americana, Coues.—*Red-headed Duck; American Pochard.*—One specimen, a male, taken June 28, 1879, by Mr. Porter.

85. FULIGULA VALLISNERIA, Stephens.—*Canvas-back Duck.*—Of occasional occurrence in summer. (*Porter.*)

86. BUCEPHALA ALBEOLA, Baird.—*Dipper Duck; Butterball.*—Frequently seen and taken in summer. (*Porter.*)

87. MERGUS MERGANSER, Linnæus.—*Shell-drake; Goosander.*—One specimen observed, evidently disabled, though still capable of distancing a sail-boat, assisted by a "cedar breeze" as we found by experiment. He did not attempt to dive, but paddling with both feet and wings, at times almost or quite raising himself clear of the water, he led us a stern chase of about three miles, until the failing breeze and approaching twilight forced us to abandon the race with a high opinion of his powers of endurance.

88. MERGUS SERRATOR, Linnæus.—*Red-breasted Merganser.*—Identified in summer by Mr. Porter.

Order STEGANOPODES: PELICANS, CORMORANTS, ETC.

Family PELECANIDÆ: *Pelicans.*

89. PELECANUS TRACHYRHYNCHUS, Latham.—*White Pelican.*—One or two instances of the occurrence of this species in summer are noted by Mr. Porter.

Family PHALACROCORACIDÆ: *Cormorants.*

90. GRACULUS DILOPHUS FLORIDANUS, Coues.—*Florida or Double-crested Cormorant.*—Two specimens, male and female, taken by Mr. Porter, in June, 1878.

Order LONGIPENES: GULLS, TERNS AND PETRELS.

Family LARIDÆ: *Gulls and Terns.*

91. STERNA HIRUNDO, Linnæus.—*Common Tern; Sea Swallow.*—Four specimens taken and others observed by Mr. Porter. We were informed that the "larger" Terns (probably this species) are quite plentiful in the marsh during rough weather, which drives them in from the lake.

92. HYDROCHELIDON LARIFORMIS, Coues.—*Black Tern.*—A very common summer resident in the marsh; nesting, or rather laying its eggs on the little islands of decaying vegetation and mud formed by sunken muskrat houses. Three eggs constitute a full set, and they are apparently rolled about in the mud purposely, until well coated, so as to hide the markings and thereby make them less conspicuous. In two or three instances only did we observe any attempt at a nest, and these would not have been recognized as such without the eggs, con-

sisting as they did of merely a few fragments of grass or bulrushes so disposed as to prevent the eggs from rolling; in most cases the eggs rested in a slight depression on the bare mud. The sun appears to be their chief incubator, although the decaying vegetation of which the abandoned muskrat houses consist, doubtless play some part in the process. In no instance did we succeed in flushing a bird from the eggs, although they would appear in pairs to the number of twenty or thirty and hover about within a few feet of our heads making a great outcry when we approached their property, which was soon to be ours by right of discovery. At other times the birds were not at all gregarious, being usually observed foraging singly or in pairs. Several young of the year were taken, thus confirming the statement of the resident who informed us that he had taken numbers of the eggs of the first brood in May. Of the dozen or more sets of eggs taken by us early in July, more than half were fresh or nearly so.

Order Pygopodes: Divers, Grebes and Auks.

Family Colymbidæ: *Loons.*

93. Colymbus torquatus, Brunnich.—*Great Northern Diver or Loon.*—Three or four specimens observed in summer. (*Porter.*)

Family Podicipidæ: *Grebes.*

94. Podiceps cornutus, Latham.—*Horned Grebe* (?)—Two sets of eggs taken July 2d. I refer, with a query, to this species as the birds were not seen in either instance. They present such differences however, in shape, coloration and complementary number, that they can hardly be credited to *P. podiceps*, and I therefore prefer to consider them under the head of *P. cornutus*, for the present at least.

These eggs are chalky-white, with a faint, though definite, tinge of pale bluish-green, much like the tint of the Least Bittern's egg, and very unlike the pale whitey-brown of the eggs of *P. podiceps* observed by us; they are also more elongated in shape than the ordinary egg of *P. podiceps*, and taper nearly equally toward both ends, which are decidedly pointed, rather more so than the eggs of *P. podiceps;* another important point of distinction is the number in a full set, which is apparently but two, the complement of *P. podiceps* being from four to eight. That our sets were probably full is indicated by the fact that one of them contained fully developed young, which *swam, and even attempted to dive*, on being placed in the water after removal from the egg. The nests were similar to those of *P. podiceps* described below, and the eggs were covered in like manner with decaying vegetation during the day and left for the sun to incubate.

The young removed from these eggs presented slight, but constant differences in the head and neck-markings, and the size of the bill, as compared with the young of *P. podiceps*, obtained in the same manner, those supposed to be *P. cornutus* being smaller, with more slender bills, less blotching about the head and neck, and none in the median line of throat.

Mr. Porter has repeatedly taken similar eggs, two in a set, during the past four or five years, but owing to the absence of the parent bird during the day, and its shyness at night, has been unable to identify it.

95. PODILYMBUS PODICEPS, Lawrence.—*Pied-billed Grebe; Water Witch; Dabchick.*—As more or less doubt appears to prevail in regard to the building of floating nests by members of the Grebe family, I desire here to testify to the fact that the nest of the present species *does* float, notwithstanding the skeptical "*it is said*" of Dr. Coues, in his remarks on the nidification of the family.*

The little floating island of decaying vegetation held together by mud and moss, which constitutes the nest of this species, is a veritable ornithological curiosity. Imagine a "pancake" of what appears to be mud, measuring twelve or fifteen inches in diameter, and rising two or three inches above the water, which may be from one to three feet in depth; anchor it to the bottom with a few concealed blades of "saw-grass," in a little open bay, leaving its *circumference entirely free;* remove a mass of wet muck from its rounded top and you expose seven or eight soiled brownish-white eggs, resting in a depression the bottom of which is less than an inch from the water; the whole mass is constantly damp. This is the nest of the Dabchick, who is out foraging in the marsh, or perhaps is anxiously watching us from some safe cover near by.

The anchoring-blades of coarse saw-grass or flags, being always longer than is necessary to reach the bottom, permit of considerable lateral and vertical movement of the nest, and so effectually provide against drowning of the eggs by any ordinary rise in the water-level such as frequently occurs during the prevalance of strong easterly winds on the lake. A small bunch of saw-grass already growing in a suitable situation is evidently selected as a nucleus for the nest, and the tops bent so as to form part of it.

During the day we invariably found the eggs concealed by a covering of muck as above described, but, as we ascertained by repeated

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* "The nest is formed of matted vegetation, close to the water, or even, *it is said*, floating amongst aquatic plants." (Key to North American Birds, p. 335.)

visits at night and in the early morning, they are uncovered at dusk by the bird who incubates them until the morning sun relieves her of her task.

The complement of eggs is usually seven, but we took one set of eight.

The above description applies equally well to any of the six nests observed by us, and to the dozens observed by Mr. Porter at the same locality, during the past four or five years; he notes, however, a few instances in which the nest instead of being entirely free at its circumference, as above described, was held in place by the surrounding "deer-tongue" (*Saggitaria?*).

DESCRIPTION OF FOUR NEW SPECIES AND A NEW VARIETY OF SILURIAN FOSSILS, AND REMARKS UPON OTHERS.

By S. A. Miller, Esq.

Eucalyptocrinus depressus, n. sp.

Plate VII., fig. 1, side view of the calyx; fig. 1*a*, basal view of the calyx; fig. 1*b*, dome and the canal leading from the dome to the top.

The calyx of this species is remarkably short and deeply depressed below. The depression at the place of the columnar attachment is equal to the height of the calyx, and the cavity embraces the first radial plates. The height of the calyx is less than half its diameter.

The first radials are large hexagonal plates. The second radials are small sub-quadrangular plates, much wider than long, and having the longer side at the base. The third radials are hexagonal, wider than long, and having the longer side resting upon the second radials. The large interradial has ten nearly equal sides, but as the angles are obtuse the form is nearly circular. It supports upon the upper sides the two interradials that support interbrachials.

The dome immediately covering the cavity of the calyx has a height almost equal to its diameter or nearly twice as great as the height of the calyx. The canal leading from the dome to the top of the interbrachials expands toward the upper end.

This species is readily distinguished from others by the extremely short calyx, deeply depressed base, and prominent dome. It will not be mistaken for *E. cornutus* var. *excavatus*, because the latter has a pentagonal excavation at the base, and is otherwise far removed from it.

Collected at Cicero and Bridgeport, near Chicago, Illinois, in magnesian limestone of the age of the Niagara Group, by W. C. Egan, Esq., of Chicago.

GLYPTOCRINUS SHAFFERI, var. GERMANUS, n. var.

Plate VII., fig. 2, view of a specimen, natural size, showing the bifurcation of the arms on the twelfth plate; fig. 2*a*, the same magnified.

This beautiful little variety is more slender and elongated than the type of *G. shafferi*, and the free arms bifurcate on the twelfth plate instead of the ninth plate as in that species. The body is also more robust in the species than in the variety.

The plates in this variety are smooth and without any evidence of ever having been sculptured. The basal plates are minute, being only visible with the aid of a magnifier. The first radials are heptagonal, and larger than the succeeding radials. The second radials are small and hexagonal. The third radials are pentagonal, and support on the upper sloping sides the free arms. The first interradials are hexagonal. These are succeeded by two small interradials, and upon the azygous side there are several more. The arm plates bear strong pinnules.

The specimens illustrated are in my collection, and were found in the Hudson River Group, at Cincinnati, at an elevation of less than 400 feet above low-water mark in the Ohio river.

GLYPTOCRINUS SHAFFERI (S. A. Miller).

Plate VII., fig. 3, specimen natural size; fig. 3*a*, the same magnified; fig. 3*b*, the column of this species wound around another crinoid column and terminating in a point; fig. 3*c*, the same magnified.

This species was described in the Cincinnati Quarterly Journal of Science, Vol. 2, p. 277 (1875), but the wood-cut illustration was incorrect. The species is readily distinguished by its small size, short calyx, coarse pinnules, and banded column. I have not reproduced the type specimen but have chosen another because it shows part of the column.

The column tapers to a point at the lower end, and therefore the species did not attach by a flattened base as *Heterocrinus simplex*, and *H. heterodactylus* attached, nor by roots as *Anomalocrinus incurvus* did. It was a free crinoid that attached itself to other objects at will, by means of an extremely flexible column. The specimen illustrated shows this character. We have the tapering end of this species wound around a crinoid column of a distinct species, almost as neat as a thread can be wound upon a spool. The column gradually tapers as it coils, until it becomes so small as to be scarcely visible to the naked

eye, the larger plates of the column which give it that banded appearance, or make it resemble a string of small spools, gradually diminish and before the column terminates it becomes as smooth as a silken thread.

It has long been a question whether or not any species in the genus *Glyptocrinus* was possessed of a base or roots, or whether, on the other hand, they were free in their habits. And this is the first instance where any positive information has been furnished on the subject. We now know that at least one species in this genus was free in its habits, floated or drifted in the waters of the ocean, and attached itself, temporarily, by means of its remarkably flexible and tapering column.

The specimens illustrated are in my collection, and were found in the Hudson River Group, at Cincinnati, at an elevation of about 360 feet above low-water mark.

Glyptocrinus baeri (Meek).

Plate VII., fig. 3, view of the plates which cover the top of the calyx.

The specimen illustrated is from the collection of I. H. Harris, Esq., of Waynesville, Ohio. It was found in the upper part of the Hudson River Group near that place. The plates are thin, angular and numerous, and each one is possessed of a little conical central elevation.

Lichenocrinus dubius, n. sp.

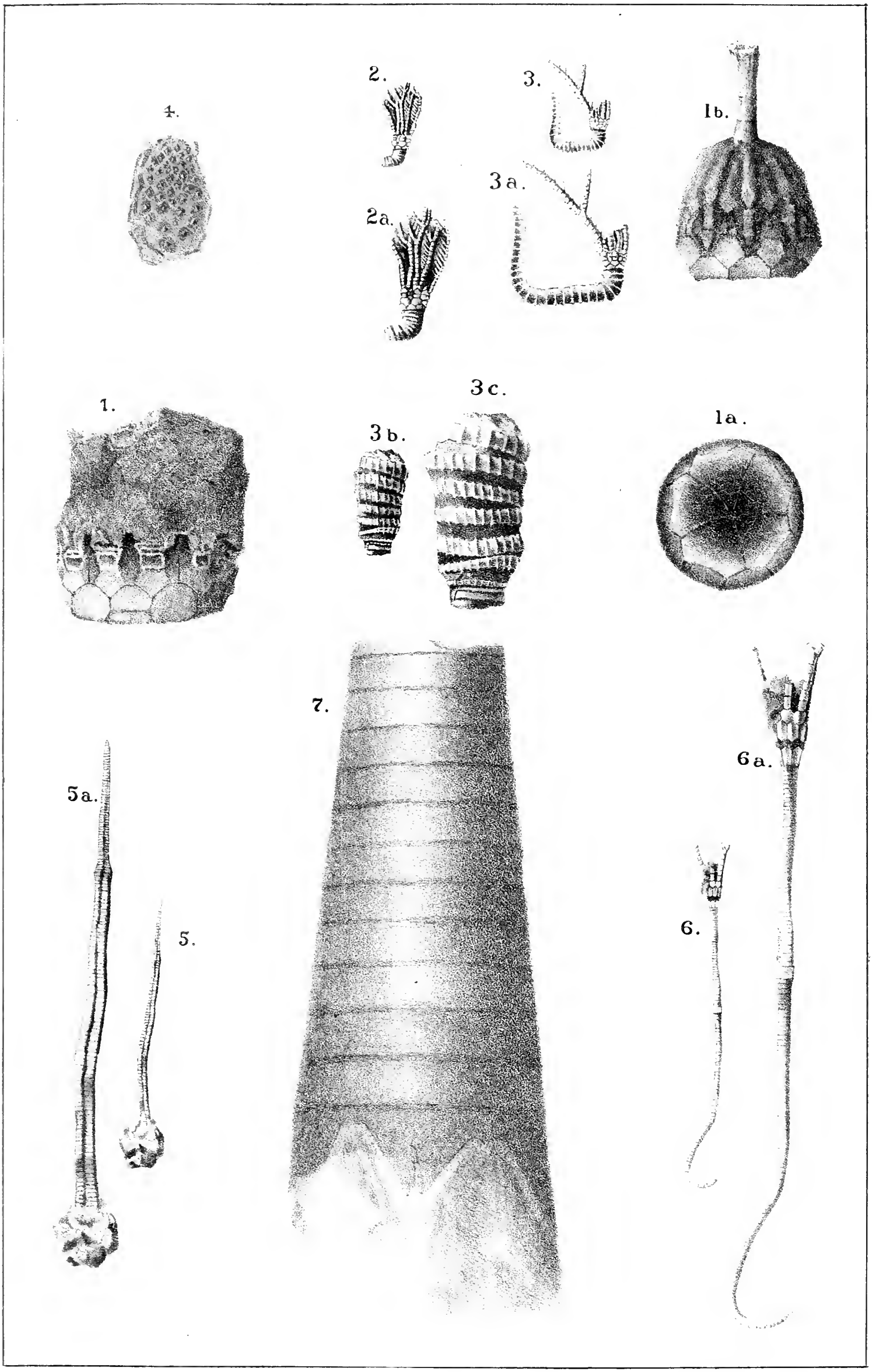
Plate VII., fig. 4, view of the column and part of the head, natural size; fig. 4*a*, magnified view.

The head is robust and covered with conical elevations. The plates are more numerous than in *L. crateriformis,* and they are thrown into elevations and depressions on the surface, which, if not abnormal, will alone distinguish this from all other species.

The column, in comparison with that of *L. crateriformis*, is short and thick. For a distance of one inch from the head, the column is fluted-pentagonal, the depressions being at the point of union of the interlocking pieces. At the distance of an inch from the head the column is abruptly contracted and changed to a plain pentagonal form. From this point the column gradually tapers and changes from the pentagonal to circular form, so that at the distance of one and one fourth inches from the head the column is round and smooth. Our specimen shows but little of the circular part of the column, but we may fairly infer from the tapering character of the column that the total length did not much exceed one and a half inches.

I collected this specimen about five years ago in the lower part of

PLATE VII.


4.
2.
3.
1b.
3a.
2a.
3c.
1.
1a.
3b.
7.
6a.
5a.
5.
6.

the Hudson River Group at Cincinnati, at an elevation of about 140 feet above low-water mark. It is the only one that I have seen. Sometimes I have thought that it is abnormal and might be *L. crateriformis*, but as there are more plates in the head of it than belong to that species, and as the head is thrown into elevations and depressions, that are not the result of disturbance occasioned by any rough surface to which it may have attached (it is now attached to the plane surface of a palmate coral), and as the column is so distinct, I have ventured to propose for it a distinct specific name. The peculiar characters of the head are not very well shown in the engraving.

I suppose that all species in this genus were free in their habits, and floated with the head downward, but attached to clay stones, shells and corals by the entire lower surface of the head whenever so-disposed. The column was free and used to direct and guide the course of the animal through the water, and perform such other functions as were performed by the columns of other floating crinoids, except that it was never used for purposes of attachment. The animals were gregarious in their habits, for we not unfrequently find a dozen or more attached to a single claystone, and sometimes they encroached upon each other and piled more or less one upon another. It is probable that they remained attached to some foreign body the greater part of the time, but the manner in which they are sometimes found, piled upon each other, shows, not that they grew in that way, but that they floated and attached in that manner by accident. In some cases, it appears as if one specimen had first attached itself to a clay stone, and afterward another in attempting to attach itself to the same object, extended itself over upon the body of the one first attaching when the latter withdrew the part so covered. This appearance of contracting and withdrawing part of the body is not of unfrequent occurrence. The head was evidently very flexible and capable of a wide expansion over a smooth surface, but always covering much less space when the surface to which it attached was rough or irregular.

DENDROCRINUS NAVIGIOLUM, n. sp.

Plate VII, fig. 5, specimen, natural size; fig. 5*a*, the same magnified.

This is a small delicate species. The head is obpyramidal. It is distinctly pentagonal at the junction with the column, and sub-pentagonal above.

The basal plates are pentagonal, longer than wide, and together form the distinctly pentagonal base of the body. Subradials hexagonal, larger than the basals, and much longer than wide. First radials shorter and wider than the subradials, and having a general heptag-

onal outline. In the only arm preserved in our specimen the first bifurcation takes place on the sixth plate from the first radial.

Column pentagonal at the body, but gradually changing to cylindrical below. In the length preserved in our specimen, it has tapered to one half the size at the body, and from the appearance, I infer that the column in this species is short and tapers to a point.

The species is founded upon the specimen illustrated, which I found in rocks of the age of the Utica Slate, within six feet of low-water mark of the Ohio river, in the first ward of Cincinnati. It bears some resemblance to *Dendrocrinus dyeri* (Meek), but may be distinguished by the more angular outline of the body, greater diameter at the first radials, and also by the form of the plates.

Orthoceras dyeri (S. A. Miller).

Plate VII., fig. 7, external view, natural size.

This species was described in the Cincinnati Quarterly Journal of Science, Vol. 2, p. 125 (1875), and illustrated by a sectional view representing the siphuncle.

The shell is rapidly tapering, chambers large, septa highly arched, and distant about one fifth the diameter of the shell. Siphuncle large, subcentral, and presenting the appearance of a string of oblate, spheroidal beads, having the same inclination as the septa between which they occur. Greatest diameter of the siphuncle nearly one third the diameter of the shell. Chamber of habitation large. Some of the shell preserved upon the chamber of habitation indicates that the surface of the shell is smooth.

It is readily distinguished from other species found in our rocks, by the rapidly tapering shell and the great distance between the septa, and in cut sections by the form of the siphuncle. It is, however, a rare species. The specimen illustrated is from my collection, and was found in the Hudson River Group, near the top of the hill west of the city of Cincinnati, at an elevation of about 400 feet above low-water mark of the Ohio river.

Palæaster clarkana, n. sp.

In July, 1878 (Jour. Cin. Soc. Nat. Hist. Vol. 1, p. 102, pl. 3, fig. 5), I described a small Palæaster under the name of *Palæaster clarkei*. It appears, however, that this name was preoccupied by de Konninck, in 1876 (Recherches sur les Fossiles Paleozoiques de la Nouvelle-Galles du Sud. p. 166, pl. 7, fig. 6 and 6*a*). Such being the fact, I now propose, for the species which I described as *Palæaster clarkei*, the name *Palæaster clarkana*.

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OF THE

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VOL. III. CINCINNATI, JANUARY, 1881. No. 4.

PROCEEDINGS OF THE SOCIETY.

TUESDAY EVENING, *October* 5, 1880.

Dr. R. M. Byrnes, President, in the chair. Present, 20 members.

Dr. Charles P. Wilson was elected a member of the Society.

Prof. G. W. Harper spoke of the multitude of a species of beetle of the family *Scarabidæ*, which he observed near Newcastle, Indiana, and of the terrible slaughter they made of each other in the wars which he saw prevailing among them.

Dr. F. W. Langdon read, by title, a paper on the Mammalia of the vicinity of Cincinnati.

The caves of Kentucky and Indiana, and the forces which excavated them, were considered and discussed by several members.

Donations were received as follows :

From E. R. Quick, a specimen of *Synaptomys cooperi*, collected near Brookville, Indiana; from Dr. A. E. Heighway, a piece of wood from the blue clay of the Drift, near Oxford, Ohio; from Rev. G. W. Dubois, a beetle, *Collosoma scrutator;* from W. C. Egan, of Chicago, Ill., specimens of *Eucalyptocrinus depressus.*

TUESDAY EVENING, *November* 2, 1880.

Dr. R. M. Byrnes, President, in the chair. Present, 24 members.

Joseph F. James read a paper by Dr. Warder, relating to the general appearance of the woods, as noticed in Kentucky and Tennessee, while passing in a train over the Cincinnati Southern Railroad.

Prof. J. W. Hall, Jr., read a communication upon the donation to the Society of a large collection of Coal Measure fossil plants, by the officers of the Rockwood Furnace, Roan county, Tennessee.

Donations were received as follows :

From Robert Clarke, the following books : The Lake Dwellings of

Switzerland, by Keller ; The History of Inventions, in 4 vols., by Beekmann ; and the Antediluvian Phytology, by Artis ; also, from same donor, a shrew from Colorada ; from Dr. D. S. Young, a pouched gopher ; from James L. Ruffin, three snakes, in alcohol ; from J. W. Shorten, six young opossums, in alcohol ; from J. E. Frey & Co., oyster shells with barnacles attached, and a singular mackerel from Pensacola, Florida ; from Dr. O. D. Norton, an Indian hoe, made from the scapula of an elk, and a small earthen vessel from Fort Berthold, Montana, and a specimen of *Smerinthus modestus*, from this vicinity ; and from the officers of the Rockwood Furnace, a collection of Coal Measure plants.

TUESDAY EVENING, *December* 7, 1880.

Dr. R. M. Byrnes, President, in the chair. In the absence of the Secretary, W. A. Dun acted as Secretary *pro tem.* Present, 20 members.

Mr. V. T. Chambers read, by title, two papers: "Two New Species of Entomostraca," and some new species of "Tineina;" and made some remarks upon the extensive development of foraminiferous Miocene strata, in California.

Prof. R. B. Warder read a paper on the recent progress in chemical dynamics.

Dr. Woodward, of Florida, through Mr. Chas. Dury, presented a box of the seeds of the "cabbage tree" (*Sabal palmetto*), containing beetles (*Caryoborus arthriticus*), an insect belonging to the family *Bruchidæ.* Mr. Dury said that the larvæ of this insect eats out the internal part of the seed as the "pea weevil" (*Bruchus pisi*) eats the pea. Of interest, in connection with these specimens is the fact that all of the insects were presented toward the opening with tail foremost, allowing them to use their powerful enlarged femurs of the posterior legs with which to kick out. Suggesting one use, at least, of this modification (action of evolution or creative eccentricity) other than their perplexing habit of jumping out of reach when the hand of the "big hunter" is thrust out to seize them.

Jos. F. James resigned as a corresponding member, and was elected to regular membership.

Prof. Mickelborough made some remarks upon part of the skull of a horse that had recently been presented to the Society.

Dr. W. A. Dun and V. T. Chambers made remarks upon the evolutions of crustaceans by changing the condition of their habitat.

Prof. Ormond Stone made some remarks upon the uncertainty of the time indicated by chronometers; and said that Prof. J. B. Bailor has determined the magnetic declination of this locality to be, approximately, 2° 15′ E. of N., at the Observatory. There is an established meridian at that place.

On motion of Dr. J. F. Judge, a committee of three were appointed to report upon the advisability of organizing a chemical section, and if favorable to report a plan for the organization of the same. The chair appointed as such committee, Dr. J. F. Judge, S. A. Miller, and L. S. Cotton.

NOTICES OF THE FLORAS OF CINCINNATI, PUBLISHED FROM 1815 TO 1879, WITH SOME ADDITIONS AND CORRECTIONS TO THE CATALOGUE OF JOSEPH F. JAMES.

By Davis L. James.

During the past sixty-five years, four floras of Cincinnati have been published. It is proposed to give some account of these, noting their especial features and extent, at the same time noticing some lists of more general scope, which are of value to the local botanist. To give an account of the botanists of early times in the west, though it would probably be of interest, would exceed the limits of our subject, and for the present, we will confine ourselves to the limits above stated.

The first attempt toward a list of the plants growing in the immediate vicinity of Cincinnati, was published by Dr. Daniel Drake, in his Picture of Cincinnati, in the year 1815.* This list, alphabetically arranged, comprises 99 species, belonging to 59 genera, beside several species and varieties of Prunus, Cratægus, Juglans, and Smilax mentioned without specific names. There is in addition a list of 35 species useful in medicine, and not included in the previous list, and a long note on Æsculus maxima, a large form of Æ. glabra, but regarded by Dr. Drake as distinct. Some notes on the economic value of native plants, with a Floral Calendar, complete the notice of the botany of the Miami valleys.

In 1835, Dr. J. L. Riddell published a synopsis of the plants of Ohio, and supplemented it by a list of additions, which, as stated on the title, was read March 16, 1836, before the Western Academy of Natural Sciences. These lists were published in the Western Journal of the Medical and Physical Sciences,† and re-issued in pamphlet form. This flora has very full notes of localities and habitats, and a flora of Cincinnati could be compiled from it. It was intended as a catalogue of the plants of the whole State, and, therefore, is not included in our enumeration. The same remark applies to Dr. Short's Catalogue of the Plants of Kentucky, printed in 1833,‡ two years before Riddell's.

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* Natural and Statistical View, or Picture of Cincinnati, and the Miami country. Illustrated by Maps, by Daniel Drake. Cincinnati, 1815, pages 76, 90.

† Volumes 8, 9—1834-5 The reprints are not obtainable.

‡ Transylvania Journal of Medicine, Lexington, Kentucky. The catalogue will be found in volume 6th, and supplements in subsequent volumes.

The second list is that of a collection made by Thos. G. Lea, during the ten years between 1833-44, and published in 1849, after his death.

This is a catalogue *par excellence*, and has not for completeness been equaled by any of the local lists. It names nearly 1,150 species of plants, including about 698 species of Phenerogams belonging to 353 genera, and 515 species of Cryptogams, belonging to 167 genera, including 19 species of Ferns, 2 species Equisetaceæ, 89 species Musci, 16 species Hepaticæ, 68 species Lichens, of which 4 were new to science, and about 320 species Fungi, of which about 50 species were new. The work of identifying the collection was divided between W. S. Sullivant, who arranged the Phenerogams, Mosses and Hepaticæ; Ed. Tuckerman, the Lichens; and the eminent fungologist, M. J. Berkeley, whose notes on the new species, with descriptions, are added as foot notes to the catalogue.

This list is very hard to obtain, and is valuable for the notes and descriptions above mentioned.* It is arranged according to the Natural System.

The third flora is that published under the title of—"A catalogue of flowering plants and ferns observed in the vicinity of Cincinnati, by Joseph Clark, with an appendix by Robert Buchanan, adopted and published by the Western Academy of Natural Sciences," in 1852, three years after the publication of Mr. Lea's list. This contains a smaller number of species than that of Lea, numbering 368 genera, and 686 species (that of Lea numbering as above, 698 species). It is arranged alphabetically, and continued the only check list till the appearance in April, 1879, of the fourth of our Cincinnati Floras, that of my brother, J. F. James. This list contains, arranged under the Natural orders, a greater number of species in the higher orders than any previous list, and includes all the phenerogamous plants and ferns observed by Lea and Clark, as well as those collected and noted by the author and his friends. It names 1,220 species, including ferns and fungi. The list of Fungi is reprinted from Lea's list, with a few additions, and a revision of the nomenclature by Prof. Chas. H. Peck. The Phenerogams alone number 869, or 171 more than Lea's.

Another list printed, but not published, in Cincinnati, is sometimes spoken of in connection with Cincinnati Botany, that of the Clark Herbarium, by Miss Rachel Bodley, and printed in 1865. Those

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* The only copy known to the writer in this city, is in the collection of the Historical Society.

plants belonging to our flora are starred, and include a number which are not in Mr. Clark's catalogue before mentioned. This list was printed at the expense of the Rev. Geo. Maxwell, who now owns the Herbarium.

It will be seen from the foregoing, that the study of Botany has not been neglected in our city, though there was a long interval, 27 years, between the appearance of the Clark and James catalogues. The early botanists were very industrious, as is shown by their thorough work in cataloguing the flora, but there is much yet to be done, and we are happy to say, that as interest in the study seems to be reviving, and that we may hope the needed work will soon be accomplished. The lower Cryptogams are almost unknown to local students. No list of our fresh water Algæ has been prepared, and the catalogues of Fungi, Mosses and Lichens of the Lea collection, need revision.

Of over one hundred species of Fungi, collected by the writer during the past year, nearly one half do not appear in the Lea list, so we may confidently predict, that with thorough work, from 400 to 500 species will be found to belong to our local flora.

To summarize, we may say that there have been collected and named as belonging to the Flora of Cincinnati, taking the James and Lea lists as a basis, 1,493 species, and safely conclude that when the neglected orders shall have been worked up, that we will have a list of from 1,800 to 2,000 species of local plants. It is true that many species are rapidly disappearing from the immediate vicinity of the city, and this may reduce the number somewhat. In this connection one word to all true lovers of Nature's Garden: the ferns, many of the scarcer forms, are in danger of entire extinction from those who pretend to love them most, and it behooves all those in earnest for the preservation of Nature's favorites to look to it, and endeavor to prevent, by personal protest, the reckless destruction of these beautiful examples of Nature's handiwork.

Indeed, to us, laws protecting ferns and wild plants seem as reasonable and as necessary as those protecting game.

For the information which enables the writer to compile the following list of corrections and additions to the catalogue of Joseph F. James, he must acknowledge his indebtedness to many friends whose interest in botany and kindness to him make the work possible. Dr. R. M. Byrnes, Dr. H. H. Hill, and Dr. J. H. Hunt, have furnished specimens and information, as noted in the proper places ; and the names of Mr. T. W. Spurlock, and Miss Kate Peachey, of Loveland, deserve more than mere mention. Mr. Spurlock, a most enthusiastic

and devoted lover of nature, has most kindly allowed me the privilege of examining all his collections, which have been many and interesting; and Miss Peachey has shown not only deep enthusiasm, but a keenness of observation seldom found among amateur botanists. Her industry during the past eighteen months, has added to our flora no less than five new species, and one new genus, beside discovering several forms which had escaped our notice, and appeared in the catalogue on the authority of Messrs. Lea and Clark.

Since the above was written, Mr. C. G. Lloyd, the present Curator of Botany in the Society, has kindly furnished us a transcript of his notes, which are included in the list that follows. These additions are, as will be seen, quite numerous, and we feel much gratified to be able, by his kindness, to record the finding of so many forms new to our published flora, viz: 19 new species, and 16 new identifications. These have all been identified by Mr. Lloyd. All others have been submitted to the writer by the collectors named.

Additions and Corrections to the Catalogue of Joseph F. James.

(Note—The numbers refer to those of the catalogue.)

RANUNCULACEÆ.

4 Anemone dichotoma, L. Add. (A. pennsylvanica, L. Syn.)

ANONACEÆ.

29 Asimina, Adams, should be Adans.

PAPAVERACEÆ.

36 Argemone Mexicana, L. Hedge rows, Undercliff, L. M. R. R.

CRUCIFERÆ.

59*a* Hesperis matronalis, L. Storrs Township, Spurlock.

65 Draba verna, L. Dr. Warder, Lockland, C. G. Lloyd.

65*a* (?) Alyssum Lescurii, Gray.

POLYGALACEÆ.

78*a* Polygala sanguinea, L. Miss Peachey, Loveland.

CARYOPHYLLACEÆ.

80 Saponaria vaccaria, L. Dr. Hunt, Valley Junction.

82 Silene nivea, DC. Miss Peachey, Loveland. T. W. Spurlock's specimen was not S. nivea.

86*a* Silene noctiflora, L. C. G. Lloyd, Crittenden, Ky.

HYPERICACEÆ.

101 Hypericum spærocarpon, Michx. Common at Loveland.

MALVACEÆ.

110*a* Hibiscus Trionum, L. Bladder Ketmia. Miss Peachey. In gardens, Loveland.

RUTACEÆ.

121*a* Xanthoxylum Americanum. Mill. Northern Prickly Ash, Toothache Tree. C. G. Lloyd.

ILICINEÆ.

123 Ilex verticellata, Gray. Miss Peachey, Loveland, Ohio.

CELASTRACEÆ.

125*a* Euonymus Americanus, L. Var. obovatus, Torr. and Gray. T. W. Spurlock, Mt. Lookout woods.

SAPINDACEÆ.

133 Æsculus flava, Ait. Dr. R. M. Byrnes. C. G. Lloyd. "Common."

ANACARDIACEÆ.

138 Rhus typhina, L. C. G. Lloyd.

LEGUMINOSÆ.

146*a* Trifolium agrarium, L. Yellow or Hop Clover. Miss Peachey, Loveland.
146*b* T. procumbens, L. Low Hop Clover.
148*a* Medicago sativa, L. Lucerne.
156 Desmodium pauciflorum, DC. J. F. J., C. G. Lloyd.
157 D. rotundifolium, DC. C. G. Lloyd.
159 D. cuspidatum, Torr. & Gray. J. F. James.
159*a* D. lævigatum, DC. C. G. Lloyd.
164 & 165 Lespedeza repens, and L. procumbens, should be united under L. repens.
177 Cassia obtusiloba, L., should be C. Tora, L.

ROSACEÆ.

188 Agrimonia parviflora, Ait. N. I. Scott.
193*a* Potentilla arguta, Pursh. C. G. Lloyd.
202 Rosa lucida, Ehrh., now R. parviflora, Ehrh.
206 Cratægus tomentosa, var. mollis. Gray. C. G. Lloyd.

LYTHRACEÆ.

228*a* Cuphea viscossissima, Jacq. Miss Peachey, Loveland. Not uncommon.

ONAGRACEÆ.

232*a* Jussiæa leptocarpa. C.G.Lloyd. Found on a floating log at the mouth of the Licking river, probably *not* naturalized.

UMBELLIFERÆ.

243 Caucalis anthriscus, Huds. T. W. Spurlock. Mt. Lookout. Common. Probably introduced with imported stock owned by Mr. Kilgour and others. Originally observed by Mr. Lloyd.
247 Archangelica hirsuta. C. G. Lloyd, Crittenden, Ky.
251*a* Bupleurum rotundifolium, L. C. G. Lloyd.
256 Chærophyllum procumbers, should be C. procumbens.

CAPRIFOLIACEÆ.

268*a* Symphoricarpus racemosus, Michx. "Naturalized." Mr. C. G. Lloyd.

RUBIACEÆ.

277*a* Galium concinuum. C. G. Lloyd. "Common."
281*a* Spermacoce glaba, Michx. C. G. Lloyd.

COMPOSITÆ.

293*a* Eupatorium altissimum, L. Red Bank, L. M. R. R.
295 E. perfoliatum, L. A variety with leaves in whorls of three, collected by T. W. Spurlock and Dr. Hill.
301*a* Aster undulatus, L.
305 A. ericoides var. villosus.
310 A. Æstivus, *erase.*
326*a* Solidago serotina, Ait. C. G. Lloyd.
351 Helianthus giganteus, L. J.F.J.
353 H. strumosus, L. C. G. Lloyd.
353*a* H. tracheliifolius, Willd. J. F. James.
360 Actinomeris helianthoides, Nutt. C. G. Lloyd.
378 Gnaphalium purpureum, L. C. G. Lloyd. Common.
386 Cnicus discolor, Spreng. C. G. Lloyd.

LOBELIACEÆ.

408*a* Lobelia leptostachys, A. DC. C. G. Lloyd, at Crittenden, Ky.

BIGNONACEÆ.

430*a* Catalpa speciosa, Engelm. Spontaneous from trees planted by Dr. Warder and others, at North Bend.

OROBANCHACEÆ.

433 Conopholis Americana, Wallroth. Miss Peachey, Cedar Bank, L.M. river. C. G. Lloyd. Crittenden, Ky.
433*a* Aphyllon Ludovicianum, Gray, (Phelipæa Ludoviciana, Don.) Dr. J. H. Hunt, Great Miami river bank.

SCROPHULARIACEÆ.

439*a* Collinsonia parviflora, Dougl. C. G. Lloyd, Crittenden, Ky.

VERBENACEÆ.

464 Verbena angustifolia, Michx. Miss Peachey, Loveland. This plant was placed in the list upon the authority of D. L. James, who had found but a single specimen.

468 V. bracteosa, Michx. C. G. Lloyd. "Common in the gutters in Newport, Ky."

LABIATÆ.

481*a* Calamintha Clinopodium, Benth. Basil. C. G. Lloyd.
484*a* Salvia lyrata, L. Lyre leaved sage. Miss Peachey, Loveland, O. C. G. Lloyd, Crittenden, Ky.
489 Blephila ciliata, Raf. C. G. Lloyd, Crittenden, Ky.
497 Scutellaria canescens, Nutt. C. G. Lloyd.

SOLANACEÆ.

543 Nicandra physaloides, Gærtn. Miss Peachey. Cultivated grounds.
546 "?" Datura metel, Locke. C. G. Lloyd.

ASCLEPIADACEÆ.

564*a* Gonolobus obliquus, R. Br. C. G. Lloyd.

CHENOPODIACEÆ.

573 Chenopodium urbicum, L. C. G. Lloyd.

AMARANTACEÆ.

581*a* Montelia tamarascina, Gray. C. G. Lloyd. This probably should be substituted for Acnida cannabina, in Clark's catalogue. The latter is a salt marsh plant.

POLYGONACEÆ.

585 Polygonum lapathifolium, Ait. (Clark's Catalogue) should be P. incarnatum, Ell.
587*a* P. acre, H. B. K.

EUPHORBIACEÆ.

616 Euphorbia obtusata, Pursh. C. G. Lloyd.
620*a* Croton capitatus, Michx. Mr. C. G. Lloyd discovered the locality. Have examined specimens collected by Mr. T. W. Spurlock.
620*b* Phyllanthus Carolinensis, Walt. C. G. Lloyd.

URTICACEÆ.

633 Parietaria Pennsylvanica. Muhl. Miss Peachey. C. G. Lloyd.

JUGLANDACEÆ.

641 Carya tomentosa, Nutt. C. G. Lloyd.

SALICACEÆ.

662*a* Salix purpurea, L. C. G. Lloyd.

ORCHIDACEÆ.

698 Pogonia pendula, Lindl., Stanage, Dr. Hill, T. W. Spurlock and others, Mt. Lookout woods.
699 Liparis lilliifolia, Richard. Not uncommon in Mt. Lookout woods, but confined to small areas.
704 Cypripedium pubescens. Willd. C. G. Lloyd. "Not uncommon at Crittenden, Ky."

LILIACEÆ.

727 Lilium superbum, L. C. G. Lloyd, Crittenden.
732 Allium tricoccum, Kalm. Miss Peachey, Bond Hill, Loveland.

CYPERACEÆ.

779 Should be Carex arida, Schw. & Torr.

GRAMINEÆ.

825*a* Spartina cynosuroides. Willd. Storrs Township, T. W. Spurlock.
835*a* Poa annua, L. Loveland, Ohio.
866 Erianthus alopecuroides, Ell. *erase.*
866*a* Andropogon furcatus, Muhl. Dr. Warder.
866*b* A. scoparius, Michx. Dr. Warder.
867 A. Virginicus, L. Loveland.

FILICES.

877 Pteris aquilina, L. C. G. Lloyd, Crittenden, Ky.
883 Camptosorus rhyzophyllus, Link. Very rare. Found by Dr. H. H. Hill, above California, Ohio.
886*a* Aspidium spinulosum, Swartz. Var. typicum. T. W. Spurlock.
887 A. Goldianum, Hook. Mr. Spurlock says has been found in Mt. Lookout woods.

OPHIOGLOSSACEÆ.

Including (Botrychium and Ophioglossum.)

897 Botrychium ternatum, Swartz. Varieties obliquum and dissectum, in woods back of Mt. Lookout, becoming rare owing to the destructive raids of the "Fern Hunters."

THE CÆNOZOIC AGE, OR TERTIARY PERIOD.

By S. A. Miller, Esq.

[*Continued from Vol. 3, page 202.*]

When the words Primary, Secondary and Tertiary are used to distinguish geological subdivisions, the rocks are so comprehended as to leave none to which the word Quaternary can be properly applied. The organic remains of the Tertiary are likewise so completely blended with the living organisms, that we can not distinguish a Quaternary age or period. The subdivision of the Tertiary, with reference to the survival of conchological species, into Eocene, Miocene, Pliocene and Post-pliocene, brings us to the living species as gradually as the species are found to change within any of the subdivisions of geological time, or within any of the minor subdivisions of the strata into groups. It is, therefore, evidently a mistake to use the word Quaternary, in a geological subdivision, with reference either to the rocks or their organic contents.

The Tertiary rocks, generally, consist of marls, clays, sands, or other friable material, filling depressions in the underlying rocks, and, though widely distributed, seldom form hard continuous strata. This condition of the rocks in Europe made it very difficult to determine the order of superposition, and led Deshayes to suggest, after having examined 1,122 species of fossil shells from the Paris basin, and having identified only thirty-eight with the living, that a subdivision of the Tertiary might be based upon the relative proportion of the extinct and living species of shells. He drew up, in tabular form, lists of all the living shells known to him as occurring in Tertiary rocks, and submitted the same to Mr. Lyell. The number of species of fossil shells examined by Deshayes was about three thousand, and the living species with which they were compared about five thousand. With this assistance, and that furnished by the works of Basterot and some Italian authors, Mr. Lyell, in 1833, estimated that, in the lower Tertiary strata of London and Paris, 3½ per cent. of the species are identical with the living; that, in the middle Tertiary of the Loire and Gironde, about 17 per cent. are living; that in the upper Tertiary, or Subappenine beds, from 35 to 50 per cent.; and that, in strata still more recent, in Sicily, from 90 to 95 per cent. He proposed to call the lower Tertiary "Eocene," which signifies the dawn of the present state of things; the middle Tertiary "Miocene," which implies less recent; and the upper Tertiary "Pliocene," which means more recent. The

Pliocene he subdivided into the Older Pliocene and Newer Pliocene. In the latter, out of 226 fossil species of shells, he found 216 to be living. He afterward proposed the name Post-pliocene for rocks having all the imbedded fossil shells identical with living species, though they may contain extinct mammalian remains. We now include in this group strata which belong to more modern time, and which are frequently called "Recent."

This subdivision of the Tertiary, with reference to the survival of conchological species, and the subdivision of the strata, or rocks, into groups, have made a double system of nomenclature, which does not prevail in the older geological periods. The determination of the North American equivalents of the European strata, by the per cent. of living species, was soon ascertained to be impracticable, and, instead of that method, the age is determined by the extinct species. Certain species have come to be regarded as types of Eocene age, or Miocene, as the case may be, and, from the presence of these, the rocks are referred to the proper subdivision of the Tertiary.

I have not found time to separate the consideration of the Tertiary, into the groups into which it has been subdivided, and preserve the chronological order, or history of our knowledge of it. For this reason, I will follow the order of discovery in matters relating to the Tertiary, separating only that part relating to the fresh water drift of the central part of the continent, which will form the conclusion of this essay; nor will I dwell upon the few vertebrate fossils mentioned prior to 1820.

In 1824, Prof. Silliman* noticed the Tertiary exposed at Martha's Vineyard and the Elizabeth Islands. Prof. Olmstead,† in the first report ever made, as it is said, in any country, upon geology, with State or Government funds, described the country through which the Beaufort canal was excavated, and separated the strata into: 1st. A black mould; 2d. Potters' clay, of a yellowish brown color; 3d. A thin layer of sand, full of sea shells and the remains of land animals, particularly of the mammoth, from three to eight feet deep; and, 4th. A soft blue clay.

Thomas Say‡ described, from strata now referred to the Miocene of Maryland, *Turritella plebeia*, *Natica interna*, *Buccinum porcinum*, now *Ptychosalpinx porcina*, *B. aratum*, *Fusus cinereus*, now *Urosalpinx cinereus*, *F. 4-costatus*, now *Ecphora quadricostata*, *Calyptraea*

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* Am. Jour. Sci. and Arts, vol. vii.
† Rep. on the Geo. of North Carolina.
‡ Jour. Acad. Nat. Sci. vol. iv., pt 1.

grandis, now *Dispotæa grandis*, *Fissurella redimicula*, *Ostrea compressirostra*, *Pecten jeffersonius*, *P. madisonius*, *P. clintonius*, *P. septenarius*, *Plicatula marginata;* and from strata now referred to the Pliocene of Maryland, *Arca arata*, *A. centenaria*, *A. incile*, *Pectunculus subovatus*, *Nucula concentrica*, *N. laevis*, *Venericardia granulata*, now *Cardita granulata*, *Crassatella undulata*, *Isocardia fraterna*, *Tellina aequistriata*, *Lucina anodonta*, *L. contracta*, *L. cribraria*, *L. subobliqua*, *Venus deformis*, *Astarte undulata*, *A. vicina*, *Amphidesma subovatum*, *Corbula cuneata*, *C. inaequalis*, *Panopœa reflexa*, *Serpula granifera*, and *Dentalium attenuatum*.

In 1825, Dr. Richard Harlan* described, from Bigbone Lick, Kentucky, *Cervus americanus*, *Bos bombifrons*, now *Ovibos bombifrons*, *B. latifrons*, now *Bison latifrons;* from a cave in Greenbriar county, Virginia, *Megalonyx jeffersoni*, and from Skidaway Island, Georgia, *Megatherium cuvieri*.

In 1828, Dr. J. E. Dekay† described, from the Post-pliocene at New Madrid, on the Mississippi river, *Bos pallasi*.

In 1829, Dr. Morton‡ arranged, from the notes of Lardner Vanuxem, some geological observations on the Tertiary and Alluvial formations of the Atlantic coast of the United States, showing their great extent and inclination from Nantucket and Martha's Vineyard, on the coast of New England, to the Mississippi river. The modern alluvial was divided into vegetable mould and river alluvium; the ancient alluvial into white siliceous sand and red earth; the Tertiary formation into beds of limestone, buhrstone, sand and clay. He described, from strata now regarded as Pliocene, *Crepidula costata*.

In 1830, Mr. Timothy A. Conrad§ showed that Tertiary deposits occupy all that part of Maryland south of an irregular line, running from the vicinity of Baltimore to Washington City, between the Potomac river and Chesapeake bay, though most of the surface is covered with a diluvial deposit of sand and gravel; and from the presence of *Turritella mortoni*, *Cucullæa gigantea*, and *Venericardia planicosta*, he regarded the deposits in the vicinity of Fort Washington as contemporaneous with the London clay of England, which now constitutes part of the Eocene of Europe. This was the first announcement of the existence of strata, of this age, in America.

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* Fauna Americana.

† Am. Lyc. Nat. Hist., N. Y., vol. ii.

‡ Jour. Acad. Nat. Sci., vol. vi., pt. 1.

§ Jour. Acad. Nat. Sci., vol. vi., pt. 2.

He described, from Maryland, in strata now regarded as of Pliocene age, *Murex acuticosta*, *Voluta solitaria*, *Cassis cœlata*, *Trochus humilis*, *T. reclusus*, *Pyrula sulcosa*, *Turritella laqueata*, *T. variabilis*, *Cancellaria lunata*; and from strata now referred to the Miocene, *Natica fragilis*, *Pleurotoma communis*, *P. dissimilis*, *P. parva*, *P. rotifera*, *Marginella denticulata*, *Nassa quadrata*, *Terebra simplex*, *Actaeon melanoides*, *A. ovoides*, *Mactra ponderosa*, *Venus alreata*, *Amphidesma carinatum*, *Arca maxillata*, and *Cardium laqueatum;* and from strata now referred to the Eocene, *Monodonta glandula*, *Turritella mortoni*, *Cucullœa gigantea*, now *Latiarca gigantea*, *Crassatella alaeformis*, and *Venericardia blandingi*.

In 1832, Prof. Edward Hitchcock* described the *alluvium* as that fine, loamy deposit, which is yearly forming from the sediment of running waters, chiefly by the inundations of rivers. It is made up of the finest and richest portions of every soil over which the waters have passed. No extensive alluvial tracts occur in Massachusetts; although limited patches of this stratum exist, not infrequently, along the banks of every stream. The *diluvium*, he said, occupied more of the surface of the State than any other stratum. It is not generally distinguished from alluvium; but it is usually much coarser, being made up, commonly, of large pebbles, or rounded stones, mixed with sand and fragments of every size, which are often piled up in rounded hills to a considerable height, and under such circumstances as preclude the probability that it could have resulted from existing streams. The Tertiary formation is represented as most perfectly developed on Martha's Vineyard, though found on the Connecticut river and in the vicinity of Boston, and in limited patches in other parts of the State. He said the difference between this formation and the diluvium is, that in the diluvium, the sand, pebbles and clay are confusedly mixed together; but in the Tertiary, these materials are arranged in regular, and generally, in horizontal layers, one above another. Hence, when the sandy stratum happens to lie uppermost, the soil will be too sandy; but if this be worn away, so that the clay lies at the surface, the soil will be too argillaceous; or if the gravel stratum be exposed, the soil can not be distinguished from diluvium.

In 1833,† he treated of the coast alluvium, which is produced by tides and currents in the ocean, that frequently transport large quantities of soil from one place to another, and cause it to accumulate in those

* Rep. on the Geo. of Mass., 1832.
† Rep. on the Geo. of Mass., 1833.

situations where the force abates or is destroyed. The Salt Marsh alluvium, which results from the decay of salt marsh plants; the silt brought over the marsh by the tides; and from the alluvial soil brought down by streams which empty through these marshes. He mentioned the submarine forests on the coast, and on Martha's Vineyard, and numerous deposits of peat, and the processes by which it is produced. He observed how rapidly the New Red Sandstone disintegrates and unites with the soil, giving a decidedly red hue to extensive tracts of land; and likewise the gneiss, which is found disintegrated to a depth of from six to ten feet, and thus covers the earth and obscures the rocks even in the hilly districts. Some varieties of trap, sienite, mica, talcose and argillaceous slates are similarly affected, and even quartz-rock is shown to slowly decompose by the action of the weather. As evidencing the latter fact, it is mentioned that the name of John Gilpin had been painted upon a smooth boulder of granular quartz within the past 150 years, and that the paint had so protected the surface beneath it, while the decomposing process went on over other parts of the rock, that the name is now found perceptibly elevated on rubbing the fingers over the stone. Three causes—rains, frost and gravity—are said to be constantly operating to degrade the hills and the mountains. In precipitous trap-ridges, water penetrates fissures, freezes, and breaks asunder the masses which constitute the slopes of broken fragments or *debris* of rocks, which arrest the attention on the mural faces of the greenstone ridges in the Connecticut valley. The gneiss rock, in Worcester county, abounds with sulphuret of iron, which is continually undergoing decomposition by the action of heat, air and moisture, and becoming changed into an oxide and sulphate. The oxide imbibes carbonic acid from the atmosphere, and is changed into a carbonate which is soluble in water; or this oxide is washed into cavities, where it meets with water containing carbonic acid, by which it is dissolved. Once dissolved, it is transported to ponds and swamps, where it is deposited by evaporation, and forms the well known bog iron ore. Rocks containing manganese are likewise undergoing decomposition, and producing, in a similar manner, the oxide of manganese.

The ridge of bowlders on the margin of some ponds, where the bottom is free from them to a considerable extent, is accounted for by the expansion of the ice in lifting them from the bottom and crowding them out, while there is no force on the melting of the ice to draw them back.

The encroachments of the sea upon the land, and the gain of the land upon the sea, are discussed. The dunes or downs are described. The Connecticut river is shown not to have excavated its own valley entirely, though proofs are offered to show that it has cut out the last ninety feet in depth, or all below the upper terrace which forms the great valley of the Connecticut. The terraces found in the river valleys are described, and their origin accounted for on the supposition that they were produced by the rivers when they run upon a higher elevation than they do at present. The action of ice floods which continue to operate energetically in the Connecticut valley, and more powerfully in the mountain torrents, are considered in relation to their effects in modifying the surface and excavating the beds of rivers. It is shown that the Connecticut river may have excavated its own valley above Mount Toby, in Sunderland, but that this is the only valley in the State which is strictly a valley of denundation.

He separated the Tertiary into the most recent Tertiary and the plastic clay. The newest Tertiary is found in the Connecticut valley, and at Cambridge, Charleston, and other places. At Deerfield, it is found more than sixty feet in thickness, and near Boston, from seventy to one hundred and twenty feet. The plastic clay is found at Nantucket and the southeastern part of the State. He considered the extensive beds of hydrate of iron in the limestone valleys of Berkshire county, and the claystones of the Connecticut valley as of Tertiary age. The latter are concretions of carbonate of lime mixed with clay, such as that in which they are found, consisting of alumina and fine sand, with occasional fine scales of mica. These concretions are round, lenticular or oblate, and frequently joined together. The diameter is from the thickness of a pigeon shot to two or more inches, and the thickness is that of a single layer of clay, which rarely exceeds one half an inch. The Tertiary of the Connecticut valley, and other interior places, he supposed to be of fresh water origin, and the plastic clay a marine formation. The latter he separated into its mineralogical characters, and described white pipe clay, blood red clay, red and white clay, bluish gray plastic clay, white siliceous sand, white micaceous sand, green sand, lignite, osseous conglomerate, and other conglomerates and minerals. He noticed the organic remains, and called attention to the fossil vegetables and animals.

In the same year, Mr. Isaac Lea* described the Tertiary at Clai-

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* Contributions to Geology.

borne, Alabama, and referred it to the age of the London clay, of England, and the *Calcaire Grossier*, of Paris. Having received Lyell's Principles, wherein the Tertiary was subdivided into Eocene, Miocene and Pliocene, he was enabled to class the Claiborne strata with the Eocene. This seems to have been the first application of the word "Eocene" to American rocks, though as above remarked, Conrad had compared American rocks with the London clay and *Calcaire Grossier*, which were afterward made the type of the Eocene period.

He described, from the Eocene at Claiborne, *Lunulites bouei*, now *Discoflustrellaria bouei*, *L. duclosi*, now *Heteractis duclosi*, *Orbitolites interstitia*, now *Lunulites interstitia*, *O. discoidea*, now *Cupularia discoidea*, *Turbinolia goldfussi*, now *Platytrochus goldfussi*, *T. maclurei*, now *Endopachys maclurei*, *T. nana*, *T. phareta*, *T. stokesi*, now *Platytrochus stokesi*, *Siliquaria claibornensis*, *Dentalium alternatum*, *D. turritum*, *Spirorbis tubanella*, *Serpula ornata*, *Teredo simplex*, *Solecurtus blainvillei*, *Anatina claibornensis*, now *Periploma claibornensis*, *Mactra dentata*, *M. grayi*, *M. pygmaea*, *Corbula alabamensis*, *C. compressa*, *C. gibbosa*, *C. murchisoni*, *Byssomya petricoloides*, *Egeria bucklandi*, *E. inflata*, now *Sphaerelia inflata*, *E. nana*, *E. nitens*, *E. ovalis*, *E. plana*, now *Tellina plana*, *E. rotunda*, *E. subtrigona*, *E. triangulata*, *E. veneriformis*, *Lucina compressa*, *L. cornuta*, *L. impressa*, *L. lunata*, *L. papyracea*, *Gratelupia moulinsi*, *Astarte minor*, now *Micromeris minor*, *A. nicklini*, *A. parva*, now *M. parva*, *A. recurva*, *A. minutissima*, now *M. minutissima*, *Cytherea comis*, *C. globosa*, *C. hydi*, *C. minima*, *C. subcrassa*, *C. trigoniata*, *Venericardia parva*, *V. rotunda*, *V. sillimani*, *V. transversa*, *Hippagus isocardioides*, *Myoparo costatus*, *Arca rhomboidella*, now *Anomalocardia rhomboidella*, *Pectunculus broderipi*, *P. deltoideus*, *P. minor*, *P. ellipsis*, now *Limopsis ellipsis*, *Nucula brongniarti*, *N. carinifera*, *N. magna*, now *Nuculana magna*, *N. media*, now *Nuculana media*, *N. ovula*, now *Nuculana ovula*, *N. pectuncularis*, now *Limopsis pectuncularis*, *N. plicata*, now *Nuculana plicata*, *N. pulcherrima*, now *Nuculana pulcherrima*, *N. sedgwicki*, *N. semen*, now *Nuculana semen*, *Avicula claibornensis*, *Pecten deshayesi*, *P. lyelli*, *Plicatula mantelli*, *Ostrea alabamensis*, *O. divaricata*, *O. linguacanis*, *O. pincerna*, *O. semilunata*, *Fissurella claibornensis*, *Hipponyx pygmæa*, now *Concholepas pygmæa*, *Infundibulum trochiforme*, *Crepidula cornuarietes*, *Bulla sthillairi*, *B. dekayi*, now *Cylichna dekayi*, *Pasithea aciculata*, *P. claibornensis*, *P. elegans*, *P. guttula*, *P. lugubris*, *P. minima*, *P. notata*, *P. secale*, *P. umbilicata*, *P. striata*, now *Actæonella striata*, *P. sulcata*, now *A.*

sulcata, *Natica gibbosa*, now *Neverita gibbosa*, *Natica magnoumbilicata*, *N. mamma*, *N. minima*, now *Lunatia minima*, *N. minor*, *N. parva*, *N. semilunata*, *N. striata*, *Actaeon elevatus*, *A. laevis*, *A. lineatus*, *A. magnoplicatus*, *A. punctatus*, *A. wetherilli*, *A. melanellus*, now *Obeliscus melanellus*, *A. striatus*, now *O. striatus*, *A. pygmaeus*, now *O. pygmaeus*, *Scalaria carinata*, *S. planulata*, *S. quinquefasciata*, *Delphinula depressa*, now *Solariorbis depressus*, *D. plana*, now *Architectonica plana*, *Solarium bilineatum*, now *Architectonica bilineata*, *S. cancellatum*, now *A. cancellata*, *S. elegans*, now *A. elegans*, *S. granulatum*, now *A. granulata*, *S. henrici*, now *A. henrica*, *S. ornatum*, now *A. ornata*, *Orbis rotella*, now *Discohelix rotella*, *Planaria nitens*, now *Solariorbis nitens*, *Turbo naticoides*, *T. nitens*, *T. lineatus*, now *Solariorbis lineatus*, *Tuba alternata*, *T. striata*, *T. sulcata*, *Turritella carinata*, *T. lineata*, *Cerithium striatum*, *Pleurotoma beaumonti*, now *Surcula beaumonti*, *P. cœlata*, now *S. cœlata*, *P. childreni*, now *S. childreni*, *P. desnoyersi*, now *S. desnoyersi*, *P. hoeninghausi*. *P. lesueuri*, *P. lonsdalei*, now *Drillia lonsdalei*, *P. monilifera*, now *Surcula monilifera*, *P. obliqua*, now *S. obliqua*, *P. rugosa*, now *S. rugosa*, *P. sayi*, now *S. sayi*, *Cancellaria babylonica*, *C. costata*, *C. elevata*, *C. multiplicata*, *C. parva*, *C. plicata*, *C. sculptura*, *C. tessellata*, *Fasciolaria elevata*, *F. plicata*, now *Latirus plicatus*, *Fusus acutus*, *F. bicarinatus*, *F. conybearei*, now *Strepsidura conybearei*, *F. crebissimus*, *F. decussatus*, *F. delabechei*, *F. fittoni*, *F. magnocostatus*, *F. minor*, *F. mortoni*, *F. nanus*, *F. ornatus*. *F. parvus*, *F. pulcher*, *F. pumilis*, *F. taiti*, *Pyrula cancellata*, *P. elegantissima*, *P. smithi*, *Murex alternata*, *Rostellaria cuvieri*, *R. lamarcki*, *Monoceras fusiforme*, *M. pyruloides*, *M. sulcatum*, now *Pseudoliva sulcata*, *Buccinum sowerbyi*, *Nassa cancellata*, *Terebra costata*, *T. gracilis*, *T. venusta*, *Mitra humboldti*, *M. lineata*, *M. minima*, *M. flemingi*, now *Caricella flemingi*, *M. fusoides*, now *Conomitra fusoides*, *Voluta cooperi*, *V. defrancei*, *V. gracilis*, *V. parkinsoni*, *V. parva*, *V. striata*, *V. vanuxemi*, *Marginella anatina*, *M. columba*, *M. incurva*, *M. ovata*, *M. plicata*, *M. semen*, *M. biplicata*, now *Ringicula biplicata*, *Anolax gigantea*, *A. plicata*, *Oliva constricta*, *O. dubia*, *O. greenoughi*, *O. minima*, *O. gracilis*, now *Lamprodoma gracilis*, *O. phillipsi*, now *L. phillipsi*, *Monoptygma alabamensis*, *M. elegans*, *Conus clairbornensis*, *Miliola marylandica*, now *Triloculina marylandica*, *Palmula sagittaria*, now *Phonemus sagittarius*, and *Rotella nana;* and from the Pliocene, *Balanus finchi*, and *Mactra clathrodon*.

T. A. Conrad* described, from the Miocene, at Yorktown, and other places in Virginia, *Mactra confraga*, *M. congesta*, *M. modicella*, *M. clathrodonta*, now *Rangia clathrodonta*, *Chama congregata*, *C. corticosa*, *Petricola centenaria*, *Pecten eboreus*, *Cytherea marylandica*, *Fulgur incilis;* and from Choptank river, near Easton, Maryland, *Corbula idonea;* from the Eocene, at Claiborne, Alabama, *Corbula oniscus*, *Venerupis subvexa*, *Cardita alticosta*, *Astarte tellinoides*, *A. ungulina*, *Pectunculus stamineus*, *P. cuneus*, now *Limopsis cuneus*, *P. trigonellus*, *Lucina dolabra*, *L. pandata*, *Nucula bella*, *N. caelata*, *Melongena alveata*, now *Cassidulus alveatus*, *Crepidula lirata*. *Solarium elaboratum*, now *Architectonica elaborata*, *Sigaretus bilix*, and *Typhis gracilis*.

In 1834, Mr. T. A. Conrad† identified the Eocene at Claiborne, Ala.; at Eutaw Springs and Nelson's Ferry, on the Santee river; at Shell Bluff, near Milledgeville, in Georgia; at Shell Bluff, on the Savannah river, fifteen miles below Augusta; at Fort Gaines, on the Chattahoochee, and other places; from all which he projected the continuity of the strata, commencing in Maryland, at Fort Washington, and extending in a southerly direction across Virginia, North and South Carolina, and westerly across Georgia, Alabama and Mississippi. His diagram, representing the strata composing the bluff at Claiborne, showed, in descending order: 1. Diluvium, 20 feet; 2. Whitish, friable limestone, 45 feet, containing *Scutella lyelli ;* 3. Six feet indurated limestone, where the fossils occur in casts; 4. Ferruginous, siliceous sand, 14 feet, containing *Cardita planicosta*, *Corbis lamellosa*, and *Pyramidella terebellata ;* 5. Sand, with a calcareous cement, 3 feet, containing *Ostrea sellaeformis ;* 6. Soft, lead-colored limestone, 70 feet, containing *O. sellaeformis* in abundance, and rarely *Plagiostoma dumosum;* 7. Friable, lead-colored limestone, of unknown thickness, containing *Cardita planicosta*, a shell very characteristic of the Eocene. He remarked that the *Plagiostoma dumosum* passed from the cretaceous rocks to the Eocene; that the Eocene at Claiborne appeared to be older than the Eocene of Europe, and older than the deposit at Fort Washington, Md.

He described, from the Eocene of the Southern States, *Tellina scandula*, *Pectunculus perplanus*, now *Limopsis perplana*, *Fusus irrasus*, *F. raphanoides*, *F. salebrosus*, *F. sexangulatus*, *F. symmetricus*, *Cassis brevicostatus*, *C. taiti*, *Cerithium nassula*, *C. solitarium*, *Ancillaria*

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* Am. Jour. Sci. and Arts., vol. xxiii.
† Jour. Acad. Nat. Sci., vol. vii., part 1.

tenera, *Fusus cooperi*, now *Clavifusus cooperi*, *Crepidula dumosa*, *Murex mantelli*, *M. septemnarius*, *Terebra polygyra*, *Serpula squamulosa*, *Cytherea nuttalli*, *C. mortoni*, *Ostrea georgiana*, and *Scutella lyelli*, now *Mortonia lyelli;* and from more recent Tertiary of the Southern States, *Anatina antiqua*, now *Periploma antiqua*, *Saxicava pectorosa*, *Pandora arenosa*; *Tellina declivis*, *T. egena*, *Cytherea obovata*, *C. pandata*, *C. reposta*, *Amphidesma subreflexum*, *Astarte concentrica*, *A. lunulata*, *A. obruta*, *A. symmetrica*, *Balanus proteus*, *Fasciolaria mutabilis*, *Turbinella demissa*, *Cancellaria perspectiva*, *C. plagiostoma*, *Trochus bellus*, *T. labrosus*, *T. lapidosus*, *T. mitchelli*, *T. philantropus*, *Pleurotoma biscatenaria*, *P. incilifera*, *P. pyrenoides*, *P. tricatenaria*, *P. virginiana*, *Turbo caperatus*, *Marginella eburneola*, *M. limatula*, *Solarium nuperum*, now *Architectonica nupera*, *Delphinula lyra*, now *Carinorbis lyra*, *Actæon novellus*, *Dentalium thallus*, *Fissurella alticosta*, *F. griscomi*, *Infundibulum gyrinum*, *Capulus lugubris*, *Turritella alticostata*, *T. octonaria*, *Cancellaria alternata*, *Pecten decemnarius*, *P. rogersi*, *Lepton mactroides*, and *Tellina biplicata*.

He also mentioned the following Pliocene fossils, which are to be found living on the coast of the United States, to wit: *Arca transversa*, *Cytherea sayana*, *C. gigantea*, *Pholas costata*, *Ostrea virginiana*, *Solen ensis*, *Amphidesma inequale*, *Saxicava rugosa*, *Venus mercenaria*, *Panopea reflexa*, *Mactra tellinoides*, *Pandora trilineata*, *Cardita tridentata*, *Lucina contracta*, *L. crenulata*, *L. divaricata*, *Corbula contracta*, *Crepidulata convexa*, *C. glauca*, *C. plana*, *Lutraria canaliculata*, *Fusus cinereus*, *Nassa trivittata*, *N. lunata*, *Natica duplicata*, *N. heros*, *Fulgur carica*, *F. canaliculatus*, *Mactra lateralis*, *Scalaria clathrus*, and *Vermetus lumbricalis*. This list does not include fossils of the newer Pliocene.

In 1836, Prof. Edward Hitchcock* described, from the Miocene at Portland, Maine, *Nucula portlandica*.

Dr. Samuel G. Morton† described, from a Miocene or Pliocene deposit, near Marietta, Ohio, *Unio petrosus*, *U. saxulum*, *U. terrenus*, *U. tumulatus*, and *Anodonta abyssina*.

In 1837, Wm. B. and Henry D. Rogers‡ described the Tertiary in the counties of Elizabeth City, Warwick, York, James City, Va., and the lower extremities of New Kent and Charles City, having a total length

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* Bost. Jour. Nat. Hist., vol. i., pt. 3.
† Am. Jour. Sci. and Arts, vol. xxix.
‡ Trans. Am. Phil. Soc., vol. v.

of about fifty miles, and a mean breadth of fourteen miles. The superficial stratum is an argillaceous and ferruginous sand, of a yellow or reddish color, with an occasional pebble or small bowlder of sandstone, or a white, silicious sand. Beneath this superficial layer, occasionally argillaceous beds of clay are found, of a yellow, blue, green, red or variegated color. In some places this clay is from twelve to fifteen feet in thickness. Below this stratum there is usually found a red ferruginous layer, from an inch to a foot in thickness. Beneath this layer there is a yellowish brown sand, frequently containing a large proportion of clay, all of which is barren of shells. Below these superficial layers occur the various shell beds of Miocene sand and clay, from which these authors described *Turritella quadristriata*, *T. terstriata*, *Natica perspectiva*, *Fissurella catilliformis*, *Arca protracta*, *Lucina speciosa*, and *Venus cortinaria*. They also described, from the Eocene greensand, *Nucula cultelliformis*, now *Nuculana cultelliformis*, *N. parva*, and *Cytherea ovata*, now *Dione ovata*.

In 1838, Mr. Conrad* said that the most northern locality known to be decidedly of Medial Tertiary age, is in Cumberland county, N. J., from whence the deposits extend southward in a very connected series, and are spread over a large portion of the Atlantic seaboard. The eastern shore of Maryland is chiefly composed of this and the superior formations, but the greensand occasionally appears. The Medial Tertiary occupies all that portion of the western peninsula south of a line running from Annapolis to Fort Washington, on the Potomac, and nearly all that part of Virginia which lies east of a line running through Fredericksburg, Richmond and Petersburg, to Halifax, in North Carolina, in which State the formation expands to its greatest breadth. The lowest stratum of the Medial Tertiary is clay; the upper stratum sand; and the intermediate strata are composed of sand and clay, either pure or intermixed. The general surface of the country is level, and it was originally covered with a forest of pine trees. The western limit is bounded by a narrow strip of the lower, or Eocene Tertiary, which reposes upon Cretaceous strata. He described, from the Miocene, *Mya producta*, *Pandora crassidens*, *Pholadomya abrupta*, *Panopæa americana*, *Corbula elevata*, *Venus tetrica*, *V. ducateli*, now *Mercenaria ducateli*, *V. rileyi*, *Cytherea metastriata*, *Sphærella subvexa*, *Saxicava bilineata*, *Mactra incrassata*, *M. subcuneata*, *Cardium acutilaqueatum*, *Lucina crenulata*, *Venus latisulcata*, now *Euloxa latisulcata*, *Astarte arata*, *A. cuneiformis*, *A. perplana*, *A. coheni*,

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* Fossils, Tertiary Formations.

Pecten virginianus, *Ostrea percrassa*, *O. subfalcata*, *O. sculpturata*, *O. disparilis*, *Myoconcha incurva*, *Modiola ducateli*, now *Volsella ducateli*, *Byssoarca marylandica*, and *Arca callipleura*.

Prof. Emmons* described the Tertiary of Lake Champlain as consisting of clays and sands, embracing, to some extent, marine shells of recent age—the whole formation in Essex county, New York, not exceeding fifty feet in thickness, and averaging only from twenty to twenty-five feet. From above, downward, the strata are, first, a fine white, or yellowish white, marine sand; second, a yellowish clay; and third, a blue clay. The yellowish clay abounds with argillo-calcareous concretions, of all shapes and forms, which appear to have been formed by molecular attraction, since the deposition of the beds. On the New York side of the lake, it does not form a continuous deposit from the head of the lake to its outlet, but interruptions occur where the older strata reach the lake shore. On the Vermont side, it covers a much greater extent of surface, and reaches from the lake to the base of the Green Mountains, or from six to twelve miles. The height above the level of the lake to which it extends, is about two hundred feet. This ancient sea occupied the Champlain basin, and the Hudson forming a continuous arm from the Gulf of St. Lawrence to the mouth of the Hudson, at New York.

In 1839, Prof. Charles T. Jackson† mentioned a recent marine Tertiary deposit, at Augusta, Maine, eighty-two feet above the level of the Kennebec river, where it is said to form the substratum of a large portion of the valley.

Wm. B. and Henry D. Rogers‡ described the Tertiary in the counties of Lancaster, Northumberland, Richmond, Westmoreland, King George, and the eastern part of Stafford, in Virginia; thus including the peninsula between the Potomac and Rappahannock rivers. This area forms the northern portion of the Tertiary of Virginia. The Miocene extends from near the bay shore, westward over the larger portion of the peninsula, while the Eocene occupies the remaining area on the west. They described from the Miocene, *Turritella fluxionalis* and *Fasciolaria rhomboidea;* and from the Eocene, *Cytherea lenticularis*, now *Dosiniopsis lenticularis*, *Crassatella capricranium*, *Cucullaea ononcheila*, now *Latiarca ononcheila*. *C. transversa*, now *L. transversa* and *Venericardia ascia*.

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* Geo. Rep. N. Y., 1838.
† Third Annual Rep. Geo. of Maine.
‡ Trans. Am. Phil. Soc., vol. vi.

Wm. Wagner* described, from the Miocene and older Pliocene, of Maryland and North Carolina, *Venus inoceriformis*, *Pecten marylandicus*, *Panopæa goldfussi*, *Mysia nucleiformis*, and *Trochus eboreus*.

In 1840, Mr. Conrad† described, from the Miocene at Chapel Hill, North Carolina, *Fulgur excavatus*, *F. contrarius*, *Conus adversarius*, and *Voluta carolinensis*, now *Mitra carolinensis*.

The Tertiary extends from the lower limit of the Cretaceous, in Connecticut,‡ to the lower part of Kent county, and has a thickness of 125 feet.

It is found§ at Gay Head, Martha's Vineyard, and occupying Long Island and the eastern part of the Atlantic States from New Jersey to Florida, and the southern part of the Mississippi valley.

Henry C. Lea‖ described, from the Eocene at Claiborne, Alabama, *Pasithea cancellata*, *P. elegans*, *P. minima*, *Actæon lævis*, *A. magnoplicatus*, *Scalaria elegans*, *S. venusta*, *Turbo parvus*, *Trochus planulatus*, *Turritella monilifera*, *T. gracilis*, *Turbinella fusoides*, *Pleurotoma cancellatum*, *Triton pyramidatum*, *Terebra constricta*, *T. multiplicata*, *Cancellaria pulcherrima*, *Buccinum parvum*, *Mitra eburnea*, *M. elegans*, *M. gracilis*, *Conus parvus*, and *Voluta dubia*.

T. A. Conrad¶ described, from the Middle Tertiary at the Natural Well, Duplin county, North Carolina, *Amphidesma constrictum*, now *Fabella constricta*, *Buccinum interruptum*, *B. multirugatum*, now *Ptychosalpinx multirugata*, *Cardita perplana*, *Cassis hodgei*, now *Galeodia hodgei*, *Cerithium carolinense*, now *Terebra carolinensis*, *C. unilineatum*, now *T. unilineata*, *Cypræa carolinensis*, *Dispotæa dumosa*, *D. multilineata*, *Gnathodon minor*, now *Rangia minor*, *Infundibulum centrale*, *Lucina radians*, *L. trisulcata*, *Lunulites denticulatus*, now *Discoporella denticulata*, *Mactra crassidens*, *M. subparilis*, *Natica caroliniana*, *N. percallosa*, *Pectunculus carolinensis*, and *P. quinquerugatus*; from Wilmington, North Carolina, *Amphidesma nuculoides*, *A. protextum*, *Cardium sublineatum*, *Cardita abbreviata*, *Pectunculus carolinensis*, and *P. aratus*.

Prof. Emmons** found the direction of the drift scratches and scorings of rock, in the eastern part of New York, conforming to that of

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* Jour. Acad. Nat. Sci., vol. viii., pt. 1.
† Am. Jour. Sci. and Arts, vol. xxxix.
‡ Geo. Sur. of Delaware, 1841.
§ Geo. of Massachusetts, 1841.
‖ Am. Jour. Sci. and Arts, vol. xl.
¶ Am. Jour. Sci. and Arts, vol. xli.
** Geo. 2d Dist. N. Y., 1842.

the great valleys. In the Champlain valley, it is nearly north and south; and in the St. Lawrence valley, northeast and southwest. The marine Tertiary of Champlain, though deposited in quiet waters, always overlies the scored and grooved surfaces. The bowlders succeed this Tertiary or are mixed with it. It is mineralogically composed in ascending order, of first, a stiff blue clay; second, a yellowish brown clay: and third, a yellowish brown sand. The second owes its color to weathering rather than to any important difference in its composition from the lower clay. Sand begins to appear in the yellowish clay, and increases gradually until it predominates, and finally becomes a pure siliceous sand. No fossils had then been discovered in the clay, but in the clay and sand and upper part of the group fossils are found as if in their native habitat, exceedingly frail, preserving their markings and edges entire, forbidding the idea that they could have been drifted into their present position. In protected places, as at Port Kent and Beauport, the thickness of the group is about 100 feet. In unprotected places, the larger part of the group has been swept away.

Commencing at Whitehall, at the head of Lake Champlain, it may be traced continuously not only the entire length of the lake, but also to Quebec and far toward the Gulf of St. Lawrence. It lines the St. Lawrence river as far as Ogdensburg. And from Whitehall south it lines the Hudson river for a long distance. The Albany clay belongs to this group, and is therefore one of the most recent of our marine formations.

Mr. Conrad* described, from the Miocene at Calvert Cliffs, Maryland, *Venus latilirata*, *Cytherea subnasuta*, *Lucina foremani*, *L. subplanata*, *Cardium leptopleura*, *Astarte varians*, *A. exaltata*, *Lima papyria*, *Arca subrostrata*, *Pleurotoma marylandicum*, *P. bellicrenatum*, *Trochus peralveatus*, *Scalaria pachypleura*, *Solarium trilineatum*, now *Architectonica trilineata*, *Infundibulum perarmatum*, *Fissurella marylandica*, *Dispotæa ramosa*, *Cancellaria biplicifera*, *C. engonata*, *Bonellia lineata*, *Turritella indenta*, *T. exaltata*, *T. perlaqueata*, *Marginella perexigua*. And also *Astrea marylandica*, incrusting *Pecten madisonius* on James river, Virginia; *A. bella*, from Newbern, North Carolina; *Cardium nicolletti*, now *Protocardia nicolletti*, from the Lower Tertiary or Jackson Group, on the Washita river, Monroe county, Louisiana; and *Fusus pachyleurus*, from the Lower Tertiary of Alabama.

Edmund Ravenel† described, from a Pliocene calcareous deposit on

* Jour. Acad. Nat. Sci., vol. viii., pt. 2. † *Ibid.*

Cooper river, about seventeen miles from Charleston, South Carolina, *Scutella caroliniana*, now *Mellita caroliniana*, and *S. macrophora*, now *Encope macrophora*.

In 1843, Mr. Conrad* described, from the Miocene at Newbern, North Carolina, Cliffs of Calvert, Maryland, Petersburg, Virginia, and other places, *Carditamera carinata*, *C. protracta*, *Arca triquetra*, *Nucula liciata*, *Pectunculus parilis*, *Pecten biformis*, *P. tricenarius*, *P. vicenarius*, *Tellina laevis*, *Lucina multistriata*, *Amphidesma æquatum*, *Crassatella turgidula*, *Crepidula spinosa*, *Fulgur rugosus*, *Buccinum bilex*, *B. filicatum*, *B. fossulatum*, *B. lienosum*, *B. praeruptum*, *B. protractum*, *B. sexdentatum*, *Cancellaria corbula*, *Oliva duplicata*, *Pyramidella arenosa*, *Fusus migrans*, *F. devexus*, *Voluta mutabilis*, *Ovula iota*, *Monodonta exoleta*, *Echinus improcerus*, *E. philanthropus*, *Venus cribraria*, *Plicatula densata*, *Crepidula densata*, *Arca propatula*, now *Granoarca propatula*, a subgenus of *Barbatia*, *A. scalaris*, *Cyrena densata*, *Mactra triquetra*, *Venus capax*, *Artemis elegans*, *Loripes elevata*, *Solen directus*, *S. ensiformis*, *Turritella bipartita*, *Scalaria procera*, *Pleurotoma multisectum*, *Buccinum harpuloides*, *Fusus cannabinus*, *Terebra curvilirata*, *Turbinolia pileolus*, *Spatangus orthonotus*, now *Amphidetus orthonotus;* from the Eocene at Chapel Hill, North Carolina, *Tellina arctata;* from Pamunkey river, Virginia, *Anomia ruffini*; and from the Jackson Group, *Anomia jugosa*. He said, that in a few hours' examination of the Miocene marl, in the vicinity of Petersburg, Va., he was enabled to collect about 100 distinct species. This locality is the western limit of the Miocene, which is here based on granite, and is the spot, in which, to search for the estuary and fresh water shells of the Miocene period. The elevation is considerably more than 100 feet above tide, and as the rise decreases toward the sea, it is probable that the primary rocks continued to be uplifted even after the era of the Miocene; indeed, how can we otherwise account for the elevation of fossiliferous beds, even of those of the Post-pliocene period.

It is an interesting fact that the Miocene estuaries were inhabited by two species of bivalves, now extinct, of the same two genera which still occur in similar situations in Florida and Alabama, that is at the confluence of rivers and bays, where the water is nearly fresh. These genera are *Gnathodon* and *Cyrena*, both of the family *Cyrenidæ*. The extinct Gnathodon has a considerable resemblance to the recent species, but the *Cyrena* is widely different from the living shell. These

* Proc. Acad. Nat. Sci., vol. i.

fossils are frequently water-worn, always with disunited valves, and appear to have been transported. Occasionally a specimen occurs not in the least abraded, a circumstance which indicates the vicinity of the Petersburg deposits to the mouth of the river. The strata occur in a meadow, and consist of blue marl, of a sandy texture, often intermixed with small gravel and ferruginous sand, full of shells; there is here also a proportion of gravel, of rounded quartz, occasionally of large size. Water-worn fragments of bivalves are abundantly intermingled with entire shells, and many species occur with connected valves. This is particularly the case with the burrowing shells, as *Panopæa*, but also, though less frequently, with the large *Venus tridacnoides*, *Crassatella undulata*, *Astarte concentrica*, *Cytherea albaria*, two species of *Chama*, and even two species of *Ostrea* are not uncommon; but there is nothing like an oyster bed in these strata which might indicate shoal water. The proportion of oysters to the other bivalves is about the same which the dredge furnished at the mouth of Cape Fear river, North Carolina, at the depth of eight fathoms.

In 1844, Prof. J. W. Bailey* identified numerous living Infusorial forms with the fossil Infusoria, from the Miocene at Petersburg, Va., and Piscataway, Md., and described several new species.

Mr. Conrad† described, from the Miocene, at Petersburg, Va., *Crepidula cymbæformis;* from the Eocene at Marlbourne, Hanover county, Va., *Cytherea eversa*, *C. liciata*, *C. subimpressa;* from Stafford county, Va., *C. pyga;* from Claiborne, Ala., *Cardita densata;* and from near Santee, South Carolina, *Pecten elixatus.*

Dr. Edmund Ravenel described, from the Miocene of South Carolina, *Pecten mortoni;* from the Eocene, *Terebratula canipes*, and *Scutella pileussinensis*, now *Mortonia pileussinensis.* And Dr. Robert W. Gibbes described, from a bed of green sand near the Santee canal, and about three miles from the head waters of Cooper river, South Carolina, *Dorudon serratus.*‡

In 1845, Prof. James Hall§ described, from Tertiary, slaty, bituminous limestone, on the dividing ridge between the waters of Muddy river flowing eastward, and those of Muddy creek flowing into Bear river on the west, in long. 111 deg., lat. 40 deg., *Mya tellinoides*,

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* Am. Jour. Sci. and Arts, vol. xlvi.

† Proc. Acad. Nat. Sci., vol. ii.

‡ This species was erroneously mentioned as Cretaceous on page 15, vol. iii,. of this Journal, or page 51 of this article.

§ Fremont's Expl. Exped.

now *Unio tellinoides*, *Pleurotomaria uniangulata*, *Cerithium fremonti*, *C. tenerum*, now *Goniobasis tenera*, *Natica* (?) *occidentalis*, and *Turbo paludinæformis*, now *Viviparus paludinæformis*.

William Lonsdale* described, from the Miocene of Virginia, *Columnaria sexradiata*, *Heteropora tortilis*, now *Multicrescis tortilis*, *Escharina tumidula*, now *Cellepora tumidula*, *C. quadrangularis*, now *Reptocelleporaria quadrangularis*, *C. informata*, now *R. informata*, *C. similis*, now *R. similis*, *C. umbilicata*, now *Multiporina umbilicata*. From the Eocene, *Ocellaria ramosa*, *Flabellum cuneiforme*, *Dendrophyllia lævis*, *Cladocera recrescens*, *Caryophyllia subdichotoma*, *Idmonea commiscens*, *I. maxillaris*, *Hippothoa tuberculum*, now *Pyriflustrella tubercula*, *Eschara incumbens*, *E. petiolus*, *E. tubulata*, *E. viminea*, *E. linea*, now *Escharinella linea*, *Lunulites distans*, *L. sexangulatus*, and *L. contiguus*. Lyell and Sowerby described *Terebratula wilmingtonensis*, now *Rhynchonella wilmingtonensis*, and *Cerithium georgianum*. And Edward Forbes described, *Scutella jonesi*, now *Clypeaster jonesi*.

In 1846, Mr. Conrad† demonstrated that the white limestone of Southern Alabama and Mississippi, which had been previously classed with the upper Cretaceous rocks, belongs more properly with the lower Eocene, and described *Dentalium arciformis*, *Fistulana larva*, *Lutraria lapidosa*, now *Pteropsis lapidosa*, *Crassatella rhomboidea*, *C. palmula*, *Amphidesma tellinula*, *Tellina sillimani*, *T. raveneli*, and *Lucina modesta*.

He found evidences of the Eocene‡ and Miocene in East Florida, and described the Tertiary of Warren county, Mississippi, and stated, that it marks a distinct era in the American Tertiary system intermediate to the Eocene and Miocene, but more nearly allied to the former. He described the Eocene at Vicksburg, and in the bluffs on the Mississippi river, and defined, from the Upper Eocene limestone of Tampa Bay, *Bulimus floridanus*, *Bulla petrosa*, *Nummulites floridanus*, *Cristellaria rotella*, *Venus penita*, now *Cryptogramma penita*, *V. floridana*, now *C. floridana*, *Nucula tellinula*, *Cytherea floridana*, and *Balanus humilis*.

Dr. Dickeson§ described, from the blue clay that underlies the diluvial drift east of Natchez, Mississippi, a fossil, *os innominatum*, that once belonged, as he supposed, to a young man about 16 years of age.

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* Quar. Jour. Geo. Soc. Lond., vol. i.
† Am. Jour. Sci. and Arts, 2d ser., vol. i.
‡ Am. Jour. Sci. and Arts, 2d ser., vol. ii.
§ Proc. Acad. Nat. Sci., vol. iii.

It was found beneath the fossil bones of the *Megalonyx jeffersoni*, and *Mastodon giganteum.*

In 1847, W. E. Logan* found marine testacea along the valley of the Ottawa, in the clays and sands that form the superficial deposits. These deposits cover the whole valley of the south Petite Nation and its tributaries ; and occur in Templeton, Hull, Nepean, Packenham, and Fitzroy, to the mouth of the Mississippi and Madawaska. They were found in Fitzroy, 330 feet above the level of the sea, and in Nepean, 410 feet above the sea, where *Saxicava rugosa* occurs in the gravel. At the mouth of Gattineau, near Bytown, not only marine shells were discovered, but in nodules of indurated clay the *Mallotus villosus*, or common capeling, a small fish, which still frequents the shores of the Gulf of St. Lawrence, was obtained in vast numbers.

Grooves and scratches on the surfaces of the rocks were met with on the Gattineau, between Farmer's and Blasdell's mills, having a direction S. 36° E ; on Glen's creek in Packenham, N. and S. ; on the Allumettes Lake, at Montgomery's clearing, S. 25° E. The shores of Lake Temiscamang, which is long and narrow, and has banks bold and rocky, rise into hills 200 to 400, and sometimes 500 feet above its surface. The general valley of the lake thus bounded presents several gentle turns, the directions connected with two of which, reaching down to the mouth of the Keepawa river (35 miles), are 158°, 191°, 156°, numbering the degrees from north as zero around by east. The parallel grooves in these reaches of the valley turn precisely with them, as if the bounds of the valley had been the guiding cause of their bearings, and they are registered on various rounded and polished surfaces projecting into the lake, and sometimes rising to 30 and 40 feet over its level. These projecting points did not deflect the grooved lines in the slighest degree. In one case, where the projecting point is 35 feet high, the furrows were observed to move over it without any deflection whatever ; so that, whatever body, moving downward in the valley, may have caused the grooves, it was not deflected by meeting an obstacle 35 feet higher than the surface of the lake. On the top of this projecting point, the grooves are crossed by another parallel set at an angle of 15°.

The Company's Post stands on a point on the east side, which cuts the lake nearly in two, at about 18 miles from the head, and it is opposite a less prominent point on the other side. These points approach to within a quarter of a mile of one another. Both are composed of

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* Geo. Sur. Can.

sand and gravel, which, on the east, form a hill 130 feet high. The southern face of this hill runs in the bearing 65°, and the gravel toward the eastward rests on flat sandstone strata, which have a smooth and partially rounded surface. The gravel and the rock constitute the north side of a deep bay. The polished rock surface exhibits well marked grooves, which come from beneath the gravel hill, nearly at right angles to the margin of the water. There is here, as in some other instances, more than one set of parallel scratches. Two of these sets cross one another in the directions 140° and 196°. In the eastern bay, at the head of the lake, near the mouth of the Otter river, parallel grooves were remarked running in the bearing 105°, which is the upward direction of the valley of that stream; and about a mile westward of the Blanche, in the same bay, in the bearing 130°, partaking of the direction of the valley, bounded by the escarpment of the limestone described as running back into the interior. On the east side of the lake, three bowlders were remarked, which had been moved by the ice the previous winter. One of them measuring 32 cubic feet, had been moved nine feet in the direction 90°; another 100 cubic feet, had been moved twelve feet in the direction 350°; another 80 cubic feet, had been moved 14 feet in the direction 350°; each had left behind it a deep, broad furrow through the gravel of the beach down to the clay beneath. In front ot the first was accumulated a heap of gravel, one foot high, with an area of 9 square feet; in front of the second was an accumulation of small bowlders weighing from 80 to 100 lbs. each. To move the second and third, the progress of the ice must have been up the lake, and the first across it. Had the gravel rested on the surface of a rock instead of clay, parallel scratches would have been the result in each case.

There are deep, water-worn holes on the banks of the Ottawa, at heights considerably above the highest level it has ever been known to attain. One of these, 18 inches in diameter, near Chenaux, is 60 feet above the existing surface of the water; another, on the island at Portage Dufort, 25 feet above the water, and 12 or 13 feet over the great flood of the preceding spring, is more than 5 feet deep, measuring 2 by 2½ feet in diameter.

Alexander Murray found Tertiary deposits on the eastern peninsula of the Province, between the Bay Chaleur and the Gulf of St. Lawrence, consisting of clay, generally of a blue color, with sand or gravel over it, and forming the banks at the mouths of the rivers. Over the clay in some cases, as at the mouth of the Chat, marine shells were found deposited in layers, 30 feet above high-water mark. At the

mouth of the Matan the clay and gravel banks are upward of 80 feet high.

Robert W. Gibbes* described, from the Eocene of South Carolina, *Pristis agassizi.*

In 1848, M. Tuomey† said that the Tertiary rocks of South Carolina are composed of beds of loose sand, clay, gravel and sandstone, together with strata of limestone, of great thickness, and beds of soft or pulverulent marl.

A line drawn from the mouth of Stevens' creek, on the Savannah, north of Hamburg, crossing the Saluda and Broad rivers, near their junction; the Wateree, at the canal; Lynch's creek at Evan's Ferry; and Thompson's creek, at the point where it enters the State, in Chesterfield district, will approximately mark the northern boundary. Wherever the rivers, in their downward course, enter this boundary, they wash away the more yielding Tertiary rocks, and expose the metamorphic, and very frequently the granitic rocks; and hence it is, that, at these points, in ascending the rivers, we meet with the first falls.

The Eocene, in South Carolina, has a thickness of 1,000 or 1,100 feet, and consists of three well-defined groups. 1. The Buhr-stone group, composed of thick beds of sand, gravel, grit, clay and buhr-stone, amounting to at least 400 feet in thickness, and underlying the calcareous beds. Its upper portions are characterized by beds abounding in silicified shells, for the most part identical with the Claiborne fossils. As these are littoral shells, they probably occupied the coast, while the Santee beds were forming in deep water. The materials of which this group is composed are the ruins of the granitic and metamorphic rocks of the upper districts. Good exposures occur at the ferry below Augusta, in the high red cliffs overlooking the town of Hamburg, between Aikin and Graniteville, on Horse creek and Cedar creek, and at the head of Congaree creek. It may be traced from Barnwell to Sumter, a distance of 100 miles, and it occurs on Huspa creek, in Beaufort district, and at many other places.

2. The Santee beds, consisting of thick beds of white limestone, marl and green sand. These are best seen on the Santee, where, interstratified with the green sand, they dip gently toward the south. The coralline marl of Eutaw is found near the upper edge of these beds. The irregular area occupied by these beds, is about 75 miles long, and 60 miles wide.

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* Jour. Acad. Nat. Sci., 2d ser., vol. i.

† Tuomey Rep. Geo. of South Carolina.

3. Next in order above the Santee beds, are the Ashley and Cooper beds, which are the newest Eocene beds of this State. The marl of these is characterized by its dark gray color and granular texture, while the remains of fishes and mammalia give its fossil remains a peculiar character. These, together with the Santee beds, have a thickness of from 600 to 700 feet.

Artesian boring has shown that the Ashley marl occurs at a depth of about 300 feet, at the City of Charleston.

The Eocene is succeeded, in South Carolina, by isolated patches of highly fossiliferous beds of sand and marl, in which Tuomey estimated the proportion of living species to amount to 40 per cent, and for this reason referred the beds to the age of the Older Pliocene. On the Waccamaw and Peedee, this older Pliocene is found super-imposed upon Cretaceous rocks, and, in general, the strata appear to have been deposited on a plane that rises gently from the Atlantic till it reaches its greatest elevation in Darlington district. The protected patches may be traced, at short intervals, from Horry to Darlington, and from thence by Lynch's creek to Sumter. It occurs on Cooper river, and at various other places.

The Post-pliocene, of South Carolina, is confined to a belt along the coast of about 8 or 9 miles in breadth. The fossils are nearly all referable to living species now inhabiting the coast ; a few, however, belong to the fauna of Florida and the West Indies. There appears to have been a slight elevation of the coast during this period.

T. A. Conrad* separated the Eocene into the Upper or Newer Eocene, found at Vicksburg, Miss., and including the white limestone of St. Stephens, and of Claiborne, Ala., and part of that in Charleston county, South Carolina, characterized by *Scutella lyelli*, *S. rogersi*, *Pecten poulsoni*, and *Nummulites mantelli*; and the limestone in the vicinity of Tampa bay, Florida, characterized by *Nummulites floridana*, *Cristellaria rotella*, and *Ostrea georgiana ;* and into the Lower or Older Eocene, consisting of the fossiliferous sands of Claiborne, and St. Stephens, Ala., of the Washita river, near Monroe, La. ; of Pamunky river, at Marlborne, and the greensand on James river, below City Point, Va., and at Fort Washington, Piscataway, and Upper Marlborough, Maryland, characterized by *Cardita planicosta*, *C. blandingi*, *Crassatella alta*, *Ostrea sellæformis*, and *Turritella mortoni*. He described,* from the Eocene, in the vicinity of Vicksburg, Mississippi, *Dentalium mississippiense*, *Fissurella mis-*

* Proc. Acad. Nat. Sci., vol. iii.

sissippiensis, *Solarium triliratum*, now *Architectonica trilirata*, *Bulla crassiplica*, *Cypræa sphæroides*, *C. lintea*, *Narica mississippiensis*, *Sigaretus mississippiensis*, *Natica mississippiensis*, *N. vicksburgensis*, *Scalaria trigintinaria*, *Turritella mississippiensis*, *Terebra divisura*, *T. tantula*, *Pleurotoma porcellanum*, *P. abundans*, *P. cochleare*, *P. congestum*, *P. cristatum*, *P. declivè*, *P. eboroides*, *P. mississippiense*, *P. rotædens*, *P. servatum*, *P. tantulum*, *P. tenellum*, *Phorus humilis*, *Buccinum mississippiense*, *Typhis curvirostris*, *Murex mississippiensis*, *Melongena crassicornuta*, *Fusus mississippiensis*, now *Ficopsis mississippiensis*, *F. spiniger*, *F. vicksburgensis*, *Chenopus liratus*, now *Aporrhais liratus*, *Ringicula mississippiensis*, *Actæon andersoni*, *Cancellaria funerata*, *C. mississippiensis*, *Triton crassidens*, *T. abbreviatus*, *T. mississippiensis*, *Cassidaria lintea*, now *Sconsia lintea*, *Cassis cœlatura*, *C. mississippiensis*, *Oniscia harpula*, *Fulgoraria mississippiensis*, *Oliva mississippiensis*, *Mitra conquisita*, now *Fusimitra conquisita*, *M. mississippiensis*, now *F. mississippiensis*, *M. cellulifera*, now *F. cellulifera*, *M. staminea*, now *F. staminea*, *M. vicksburgensis*, *Caricella demissa*, *Scobinella cœlata*, *Turbinella perexilis*, *T. protracta*, *T. wilsoni*, *Panopea oblongata*, *Mactra funerata*, *M. mississippiensis*, *Amphidesma mississippiense*, *Psammobia lintea*, now *Gari lintea*, *P. papyria*, now *G. papyria*, *Crassatella mississippiensis*, *Cardium eversum*, *C. diversum*, now *Protocardia diversa*, *C. vicksburgense*, *Tellina pectorosa*, *T. serica*, *T. vicksburgensis*, *Donax funerata*, *Cytherea astartiformis*, *C. imitabilis* *C. mississippiensis*, *C. sobrina*, *C. perbrevis*, *Corbis staminea*, *Lucina mississippiensis*, *L. perlævis*, *Loripes eburnea*, *L. turgida*, *Corbula alta*, *C. engonata*, *C. interstriata*, *Chama mississippiensis*, *Pectunculus arctatus*, *Nucula sericea*, *N. vicksburgensis*, *Arca mississippiensis*, *Byssoarca lima*, *B. mississippiensis*, *B. protracta*, *Avicula argentea*, *Modiola mississipiensis*, now *Volsella mississippiensis*, *Pinna argentea*, *Lima staminea*, *Ostrea vicksburgensis*, *Pholas triquetra*, *Madrepora mississipiensis*, *M. vicksburgensis*, *Turbinolia caulifera*, now *Osteodes cauliferus*, *Lunulites vicksburgensis*, now *Oligotresium vicksburgense*. From the Eocene, at Claiborne, Alabama, and other places, *Ampullaria* (?) *perovata*, *Turbinolia elaborata*, now *Osteodes elaboratus*, *Madrepora vermiculosa*, now *Dendrophyllia vermiculosa*; and from St. Matthews Parish, Orangeburg District, South Carolina, *Nucula calcarensis*, *N. carolinensis*, *Cardita bilineata*, *C. carolinensis*, *C. vigintinaria*, *C. subquadrata*, *C. subrotunda*, *Turbo biliratus*, *Cerithium siliceum*, *C. bicostellatum*, *Infundibulum carinatam*, *Tellina subæqualis*, *Madrepora punctulata*, *Nautilopsis vanuxemi*. From the

Miocene of Suffolk and Yorktown, Virginia, and other places, *Eulima eborea*, *E. migrans*, *Odostomia limnia*, *O. protexta*, *Delphinula arenosa*, now *Angaria arenosa*, *Bulla subspinosa*. From the Eocene of the Southern States,* *Kellia oblonga*, *Tellina perovata*, *Cytherea lenis*, *Nucula impressa*, now *Yoldia impressa*, *N. claibornensis*, *N. parilis*, *Lithodomus claibornensis*, now *Lithophagus claibornensis*, *Cerithium claibornense*, *Amphidesma peroratum*, and *Psammobia mississippiensis*, now *Gari mississippiensis*. From the Columbia river,† near Astoria, *Nucula abrupta*, *N. cuneiformis*, *N. divaricata*, *N. penita*, *Mactra albaria*, *Tellina oregonensis*, *T. obruta*, *Loripes parilis*, *Solen curtus*, *Cytherea oregonensis*, *C. vespertina*, *Bulinus petrosus*, now *Cylichna petrosa*, *Pyrula modesta*, and *Fusus oregonensis*.

Dr. Joseph Leidy‡ described, from the Miocene of Nebraska and the west, *Pœbrotherium wilsoni*, and *Merycoidodon culbertsoni*, now *Oreodon culbertsoni*. Dr. S. G. Morton described, from the Eocene of Washington county, Alabama, *Cidaris alabamensis*, and *Galerites agassizi*. And Dr. Robert W. Gibbes described, from the Eocene of South Carolina, *Carcharodon mortoni*, *C. acutidens*, *C. lanciformis*, *Oxyrhina sillimani*, *Otodus lævis*, and *Glyphis subulata*.

In 1849, T. A. Conrad§ described, from the Upper Eocene of Vicksburg, Mississippi, *Clavella vicksburgensis*, now *Fasciolaria vicksburgensis*, *Fulgur nodulatum*, and *Triton subalveatus*. And Robert W. Gibbes described, from the Eocene of South Carolina, *Galeocerdo contortus*, and *Oxyrhina wilsoni*.

In 1850, W. E. Logan‖ said that in the valleys of the Gouffre and the Murray Bay rivers, as well as along the margin of the St. Lawrence between them, there are, at various parts, great accumulations of clay and sand, with some gravel; and it is very perceptible that while they often present a confused aggregation of hummocks in the lower grounds, at higher levels, lying in horizontal beds, they are arranged into a succession of opposite terraces of equal height along the sides of the valleys, and corresponding terraces at intervals along the St. Lawrence, all probably marking ancient beaches or periods of retrocession of a Tertiary sea by the elevation of the land. One of these terraces, in the valley of the Gouffre, has a height, as indicated by a spirit level, of 130 feet above the Bay St. Paul, and another has a height of 360 feet.

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* Jour. Acad. Nat. Sci., 2d ser., vol. i.

† Am. Jour. Sci. and Arts, 2d ser., vol. v.

‡ Proc. Acad. Nat. Sci., vols. iii. and iv.

§ Jour. Acad. Nat. Sci., 2d ser., vol. i.

‖ Geo. Sur. of Canada.

The deposits in which these terraces have been worn consist of clay, containing marine shells, among which are *Tellina groenlandica*, *T. calcarea*, *Saxicava rugusa*, *Nucula*, *Venus*, *Mytilus*, and *Balanus*. These shells were found as high as 390 feet above the bay. At Little Malbaie there are six terraces, plainly distinguishable, one above another.

T. A. Conrad* described, from the Eocene of Georgia, *Mitra georgiana*, *Catopygus conradi*, now *Cassidulus conradi*, *Holaster mortoni*, *Nucleolites lyelli*, *Discoidea haldemani*, and *Cidarites mortoni*. Robert W. Gibbes described, from the Eocene of Ashley river, *Myliobates holmesi*. And Zadock Thompson† described, from the drift in Vermont, exposed in excavating for the Rutland and Burlington railroad, *Delphinus vermontanus*, now *Beluga vermontana*.

In 1851, Philip T. Tyson‡ described the Sacramento Valley as a long prairie, occupying the space between the flanks of the Sierra Nevada and those of the Coast Range, closed in on the north by the terminal spurs of the Cascade mountains, and on the south by the junction of the Coast Range with the Sierra Nevada. Its greatest width is less than 60 miles, but it maintains a mean width of nearly 50 miles throughout almost its entire length. The surface strata are not older than the Eocene or Miocene, and rest immediately upon the metamorphic and hypogene rocks.

Prof. James Robb§ showed the direction of the Drift striæ in New Brunswick to be, generally, about 10 deg. W. of true north to 10 deg. E. of south, but that some striæ have a direction N. 30 deg. E. Others N. 45 deg. W., and still others east and west.

T. T. Bouve‖ described, from the Eocene of Georgia, *Catopygus patelliformis*, now *Cassidulus patelliformis*, and *Hemiaster conradi*.

In 1852, Mr. J. Evans¶ explored that region of the Upper Missouri country, lying high up on White river, called the "*Mauvaises Terres*," or "Bad Lands." He said that from the high prairies, which rise in the back, by a series of terraces or benches toward the spurs of the Rocky Mountains, the traveler looks down into an extensive valley, that may be said to constitute a world of its own, and which appears to have been formed partly by an extensive vertical fault, and partly by the long continued influence of the scooping action of denudation.

* Jour. Acad. Nat. Sci., 2d ser., vol. ii.
† Am. Jour. Sci. and Arts, 2d ser., vol. ix.
‡ Geo. and Ind. Resources of Cal.
§ Proc. Am. Ass. Ad. Sci., 4th Meeting.
‖ Proc. Bost. Soc. Nat. Hist., vol. iv.
¶ Geo. Sur., Wis., Iowa and Minn.

The width of this valley may be about 30 miles, and its whole length about 90. as it stretches away westwardly toward the base of the gloomy and dark range of mountains known as the Black Hills. Its most depressed portion, 300 feet below the general level of the surrounding country, is clothed with scanty grasses, and covered by a soil similar to that of the higher ground.

To the surrounding country, however, the Mauvaises Terres present the most striking contrast. From the uniform, monotonous, open prairie, the traveler suddenly descends, one or two hundred feet, into a valley that looks as if it had sunk away from the surrounding world, leaving, standing all over it, thousands of abrupt, irregular, prismatic, and columnar masses, frequently capped with irregular pyramids, and stretching up to a height of from one to two hundred feet or more.

So thickly are these natural towers studded over the surface of this extraordinary region, that the traveler threads his way through deep, confined, labyrinthine passages, not unlike the narrow, irregular streets and lanes of some quaint, old town of the European continent. Viewed in the distance, indeed, these rocky piles, in their endless succession, assume the appearance of massive, artificial structures, decked out with all the accessories of buttress and turret, arched doorway and clustered shaft, pinnacle, and finial and tapering spire.

One might almost imagine oneself approaching some magnificent city of the dead, where the labor and the genius of forgotten nations had left behind them a multitude of monuments of art and skill.

On descending from the heights, however, and proceeding to thread this vast labyrinth, and inspect, in detail, its deep, intricate recesses, the realities of the scene soon dissipate the delusions of the distance. The castellated forms, which fancy had conjured up have vanished; and around one, on every side, is bleak and barren desolation.

Then, too, if the exploration be made in midsummer, the scorching rays of the sun, pouring down in the hundred defiles that conduct the wayfarer through this pathless waste, are reflected back from the white or ash-colored walls that rise around, unmitigated by a breath of air, or the shelter of a solitary shrub.

The drooping spirits of the scorched geologist are not permitted, however, to flag. The fossil treasures of the way, well repay its sultriness and fatigue. At every step, objects of the highest interest present themselves. Embedded in the debris, lie strewn, in the greatest profusion, organic relics of extinct animals. All speak of a vast fresh water deposit of the early Tertiary period, and disclose the former existence of most remarkable races that roamed about in by-

gone ages high up in the valley of the Missouri, toward the source of its western tributaries, where now pasture the big-horned *Ovis montana*, the shaggy buffalo, or American bison, and the elegant and slenderly constructed antelope.

A section of the Tertiary of the "Bad lands," or, "Mauvaises Terres," in descending order, is as follows: 1. Ash colored clay, cracking in the sun, containing siliceous concretions, 30 feet. 2. Compact, white limestone, 3 feet. 3. Light gray, marly limestone, 8 feet. 4. Light gray, indurated, siliceous clay (not effervescent), 30 feet. 5. Aggregate of small angular grains of quartz, or conglomerate, cemented by calcareous earth, slightly effervescent, 8 feet. 6. Layer of quartz and chalcedony (probably only partial), 1 inch. 7. Light gray, indurated, siliceous clay, similar to No. 4, but more calcareous, passing downward into pale flesh colored, indurated, siliceous, marly limestone, turtle and bone bed, 25 feet. 8. White and light gray, calcareous grit, slightly effervescent, 15 feet. 9. Similar aggregate to No. 5, but coarser, 8 feet. 10. Light green, indurated, argillaceous stratum (slightly effervescent); Palæotherium bed, 20 feet.

Dr. Joseph Leidy described, from the Eocene of Nebraska, *Eucrotaphus auritus*, and from the Miocene of Virginia,* *Crocodilus antiquus*, now *Thecachampsa antiquus*. Prof. F. Unger† described, from the Tertiary of Texas, *Sillimania texana*, *Rœmeria americana*, and *Thuioxylon americanum*.

In 1853, Alexander Murray‡ informed us that the clays on the Ottawa, in the vicinity of Bytown, at the mouth of the Gatineau on the north, and of Green's creek on the south side, in addition to marine shells, yield, in the latter locality, two species of fish, the *Mallotus villosus*, and *Cyclopterus lumpus*, or lump-sucker, the former now living and frequenting the Gulf of St. Lawrence in great numbers, and the latter abounding on the northern shores of Scotland and America. The fossils are enclosed in nodules of indurated clay of reniform shapes, and occupy a bed nearly on a level with the water of the Ottawa, and about 118 feet above the tide level of Lake St. Peter. The same sort of nodules frequently enclose fragments of wood, leaves of trees, and portions of marine plants; among the last is one of the species of littoral algæ still found near the coasts of Arctic seas. Beside the stratified deposits of clay and sand, there is a deposit of clay drift, holding pebbles and bowlders, sometimes angular, but generally

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* Jour. Acad. Nat. Sci., 2d ser., vol. ii.
† Kreid. von Texas.
‡ Geo. Sur. of Canada.

rounded, showing no decided lines of stratification, but irregularly associated with isolated beds of gravel and sand, among which great quantities of marine shells of comparatively recent origin occur. One of these localities is on the Prescott Road, about a mile and a half from Kemptville, where a vast accumulation of *Tellina grœnlandica* overlays a two feet bed of limestone gravel, the latter resting on gravel of a still coarser quality, and of more angular fragments, and irregularly mixed up with sand and clay, some of the bowlders being from 6 to 10 inches in diameter. The height of this locality is about 350 feet over Lake St. Peter. At another locality, near Armstrong's Mills, the shells consist chiefly of *Saxicava rugosa*, mixed with sand and loam, at a height of about 300 feet above Lake St. Peter. In Kenyon, on the Garry river, these shells occur at the height of 270 feet above Lake St. Peter. On the road between the 5th and 6th concessions of the township, on the 19th and the 21st lots, these shells occur at the height of 330 or 340 feet above Lake St. Peter. Two localities occur in Lochiel, one of them on the 15th lot of the 1st concession, at the height of 264 feet, and the other on the 5th lot of the same concession, 280 or 290 feet above Lake St. Peter, where the marine shells are mixed with the sand, and where bowlders and fragments of limestone and sandstone abound.

Prof. Edward Hitchcock* described the brown coal deposit in Brandon, Vermont, and referred it to the Pliocene or Newer Tertiary. He found it abounding in fruits and lignites, which appear to have been transported by water, and probably accumulated in an ancient estuary. It abounds in white and variegated clays, water-worn beds of sand and gravel, beds of carbonaceous matter not bituminous, and deposits of iron and manganese.

T. A. Conrad† described, from the Miocene of Upper California, *Gnathodon lecontei*, now *Rangia lecontei*, and *Ostrea vespertina.*

In 1854, Dr. Leidy‡ described, from the Post-pliocene, of Ashley river, South Carolina, *Arctodus pristinus*, from Kansas, *Camelops kansanus;* and from the mouth of Pigeon creek, below Evansville, Ind., *Canis primævus*, now *C. indianensis.* From the Pliocene, on Bijou Hill, east of the Missouri river, *Hippodon speciosus*, now *Hippotherium speciosum*, and *Merycodus necatus*, now *Cosoryx necatus;* from the Miocene of Nebraska, *Deinictis felina.*

Evans and Shumard described, from the Tertiary (White Riv. Gr.),

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* Am. Jour. Sci. & Arts, 2d ser., vol. xv.
† Jour Acad. Nat. Sci., 2d ser., vol. ii.
‡ Proc. Acad. Nat. Sci., vol. vii.

in Nebraska, in the vicinity of Peno creek, a small tributary of Teton, or Little Missouri river, in a thin bedded, light gray, siliceous limestone, near the summit of the elevated plateaux which border the Mauvaises Terres, *Planorbis nebrascensis*, *Limnæa diaphana*, *L. nebrascensis*, *Physa secalina*, and *Cypris leidyi*.

T. A. Conrad* described, from the (Jackson Group) Greensand Marl-bed of Jackson, Mississippi, *Astarte parilis*, *Umbrella planulata*, *Corbula bicarinata*, *C. densata*, *Leda multilineata*, now *Nuculana multilineata*, *Navicula aspera*, *Crassatella flexura*, *Glossus filosus*, now *Axinæa filosa*, *Ostrea trigonalis*, *Pecten nuperus*, *Capulus americanus*, *Clavelithes humerosus*, *C. varicosus*, *C. mississippiensis*, now *Papillina mississippiensis*, *Trochita alta*, *Mitra dumosa*, now *Lapparia dumosa*, *Conus tortilis*, *Volutilithes symmetricus*, *V. dumosus*, *Rostellaria velata*, now *Calyptrophorus velatus*, *R. Staminea*, now *C. stamineus*, *Caricella subangulata*, *C. polita*, *Natica permunda*, *Rostellaria extenta*, now *Platyoptera extenta*, *Mitra millingtoni*, now *Fusimitra millingtoni*, *Teredo mississippiensis*, *Architectonica acuta*, *A. bellistriata*, *Cypræa pinguis*, *C. fenestralis*, *Gastridium vetustum*, *Phorus reclusus*, *Turritella alveata*, *Galeodia petersoni*, and *Strepsidura dumosa*.

Dr. J. W. Dawson,† describing the drift of Nova Scotia, in 1855, said, that in the low country of Cumberland there are few bowlders, but of the few that appear, some belong to the hard rocks of the Cobequid hills to the southward; others may have been derived from the somewhat similar hills of New Brunswick. On the summits of the Cobequid hills, and their northern slopes, we find angular fragments of the sandstones of the plain below, not only drifted from their original sites, but elevated several hundreds of feet above them. To the southward and eastward of the Cobequids, throughout Colchester, Northern Hants, and Pictou, fragments from these hills, usually much rounded, are the most abundant traveled bowlders, showing that there has been great driftage from this elevated tract. In like manner, the long ridge of trap rocks, extending from Cape Blomidon to Briar Island, has sent off great quantities of bowlders across the sandstone valley which bounds it on the south, and up the slopes of the slate and granite hills to the southward of this valley. Well characterized fragments of trap from Blomidon may be seen near the town of Windsor, and unmistakable fragments of similar rock from Digby neck, on the Tusket river, may be seen, thirty miles from their original position. On the

* Wailes' Geo. of Miss.
† Acadian Geology.

other hand, numerous bowlders of granite have been carried to the northward from the hills of Annapolis, and deposited on the slopes of the opposite trappean ridge; and some of them have been carried round its eastern end, and now lie on the shores of Londonderry and Onslow. So, also, while immense numbers of bowlders have been scattered over the south coast from the granite and quartz rock ridges, immediately inland, many have drifted in the opposite direction, and may be found scattered over the counties of Sydney, Pictou and Colchester. These facts show that the transport of traveled blocks, though it may have been principally from the northward, has, by no means been exclusively so; bowlders having been carried in various directions, and more especially from the more elevated and rocky districts to the lower grounds in their vicinity.

The surface of the country was greatly modified by the drift; the ridges of Cumberland, the deep valleys of Cornwallis and Annapolis, the great gorges crossing the Cobequid mountains, and the western end of the North mountains in Annapolis and Digby counties, such eminences as the Greenhill in Pictou county, and Onslow mountain in Colchester, are due in great part to the removal of soft rocks by denuding agencies of this period, while the harder rocks remained in projecting ridges. The surface of the rocks are frequently found polished, scratched or striated. The striæ at different places have different courses, and sometimes they are found to cross each other as at Gore mountain, where one set is S. 65 deg. E., and the other S. 20 deg. E. At Gay's river, Musquodoboit Harbor, and near Guysboro the direction is from S. to N. At Polson's Lake, from N. to S., and near Pictou, E. & W. Bowlders or traveled stones are often found in places where there is no other drift. For example, on bare granite hills, about 500 feet in height, near the St. Mary's river, there are large, angular blocks of quartzite, derived from the ridges of that material which abound in the district, but are separated from the hills on which the fragments lie by deep valleys.

The only evidence of organic life during the bowlder period, or immediately before it, noticed by Dr. Dawson, consists of a hardened, peaty bed, which appears under the bowlder clay on the northwest arm of the River of Inhabitants. It rests upon gray clay, similar to that which underlies peat bogs, and is overlaid by nearly twenty feet of bowlder clay. Pressure has rendered it nearly as hard as coal, though it is somewhat tougher and more earthy than good coal. It has a glossy appearance when rubbed or scratched with a knife, burns with considerable flame, and approaches in its characters to the brown

coals, or more imperfect varieties of bituminous coal. It contains many small roots and branches, apparently of coniferous trees allied to the spruces. The vegetable matter composing this bed, must have flourished before the drift was spread over the province, so that it belongs to some part of the great Tertiary group of rocks, of which the drift is the latest member.

Dr. Dawson accounted for the drift phenomena of Nova Scotia, in this manner. Let us suppose the surface of the province, while its projecting rocks were uncovered by surface deposits, exposed for many successive centuries to the action of alternate frosts and thaws—the whole of the untraveled drift might have been accumulated on its surface. Let it then be slowly submerged, until its hill-tops should become islands or reefs of rocks in a sea loaded in winter and spring with drift ice, floated along by currents, which, like the present Arctic current, would set from N. E. to S. W., with various modifications produced by local causes. We have, in these causes, ample means for accounting for the whole of the appearances, including the traveled blocks and the scratched and polished rock surfaces.

The *stratified sand and gravel* rests upon and is newer than the unstratified drift. This may often be seen in coast sections or river banks, and occasionally in road-cuttings. In Pictou county there occurs a very thick bed of conglomerate, of the age of the Coal Measures, the outcrop of which, owing to its comparative hardness and great mass, forms a high ridge extending from the hill behind New Glasgow, across the East and Middle rivers, and along the south side of the West river, and then crossing the West river reappears in Rogers Hill. The valleys of these three rivers have been cut through this bed, and the material thus removed has been heaped up in hillocks and beds of gravel, along the sides of the streams, on the side toward which the water now flows, which happens to be the north and northeast. Accordingly, along the course of the Albion Mines railway, and the lower parts of the Middle and West rivers, these gravel beds are everywhere exposed in the road-cuttings, and may in some places be seen to rest on the bowlder-clay, showing that the cutting of these valleys was completed after the drift was produced. The stratified gravels do not, like the older drift, form a continuous sheet spreading over the surface. They occur in mounds, and long ridges, sometimes extending for miles over the country. They are supposed to have been distributed when the country was being elevated, while the bowlder drift was deposited when the land was subsiding beneath the sea.

T. A. Conrad separated the Eocene of Mississippi and Alabama, in

ascending order, into : 1. Claiborne group, characterized by *Cardita densata*, *Ostrea selliformis*, *Crassatella alta*, *Pectunculus stamineus*, *Meretrix æquorea*, *Gratelupia hydi*, *Leda cælata*, and *Crepidula lirata*. 2. Jackson group. characterized by *Umbrella planulata*, *Cardium nicollettii*, *Conus tortillis*, *Cypræa fenestralis*, *Galeodia petersoni*, and *Rostellaria extenta*. 3. St. Stephen's group, characterized by *Pecten poulsoni*, and *Orbitulites mantelli*. 4. Vicksburg group, characterized by *Corbula alta*, *Crassatella mississippiensis*, *Arca mississippiensis*, *Meretrix sobrina*, *M. imitabilis*, and *Turbinella wilsoni*. He described,* from Jackson, Miss., and Claiborne, Ala., *Endopachys expansum*, *E. triangulare*, *E. alticostatum*, *Flabellum wailesi*, *Osteodes irroratus*, *Turbinolia lunulitiformis*, *Chiton antiquus*, *C. eocenensis*; and from White river, Arkansas, *Petrophyllia arkansasensis*; from the Miocene, of Colorado and the West, *Anomia subcostata*, *Mercenaria perlaminosa*, *Pecten heermani*, *Pandora bilirata*, *Astarte thomasi*, *Turritella secta*, *Ostrea contracta*, and *Idmonea californica*.

Prof. Wm. P. Blake noticed Miocene strata, containing the remains of Infusoria and Polythalamia, near Monterey, California. The strata are white, porous, light, resemble chalk, and are situated about two miles southeast from the center of Monterey, and form part of a hill which fronts the bay, and rises on the east side of the stage-road to San Francisco to the height of 500 or 600 feet.

Tuomey and Holmes† described, from the Pliocene of South Carolina, *Cellepora formosa*, *C. depressa*, *C. radiata*, *C. tessellata*, *Membranipora lacinia*, *Placunanomia plicata*, *Ostrea ravenelana*, *Janira affinis*, *Pecten comparilis*, *P. peedeensis*, *Mytilus inflatus*, *Arca hians*, *A. rustica*, *Pectunculus lævis*, *Lucina costata*, *Crassatella gibbesi*, *Psammocola pliocena*, *Dentalium pliocenum*, *Hipponix bulli*, *Monodonta kiawahensis*, *Trochus armillatus*, *T. gemma*, *Terebellum striatum*, *T. burdeni*, *T. etiwanensis*, *Voluta trenholmi*, *Porcellana oliviformis*, *Purpura tridentata*, *Cancellaria depressa*, *C. venusta*, *Busycon conradi*, *Cassidulus carolinensis*, and *Fasciolaria tuomeyi*.

J. McCrady described, from the same strata, *Psammechinus exoletus*, *Agassizia porifera*, *Amphidetus ampliflorus*, *A. gothicus*, *Brissus spatiosus*, *Plagionotus holmesi*, and *P. ravenelanus*.

Dr. Trask‡ described, from the Pliocene of Santa Barbara, California, *Chemnitzia papillosa*, *Tornatella elliptica*, *Murex fragilis*, *Fusus barbarensis*, *F. robustus*, and *F. rugosus*.

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* Proc. Acad. Nat. Sci., vol. vii.
† Tuomey and Holmes' Fossils of South Carolina.
‡ Proc. Cal. Acad. Sci., vol. i.

In 1856, W. P. Blake* described the Tertiary rocks of the vicinity of San Francisco, California. They consist of fine-grained, compact sandstone, associated with shales, and underlie the city of San Francisco, and are exposed along the shores of the bay, both north and south of the city, forming the principal promontories and points, and several islands. On entering the bay from the Pacific, they are first seen at Point Lobos, the outer point, and again at North and Tonquin points. They border part of the Golden Gate on the north, and form the shores of Richardson and Sancelito bays. Angel, Yerba Buena and Alcatrazes Islands, are of the same age. In some places, hills and ridges of 200 or 300 feet in elevation are formed entirely of this sandstone. Rocks of the same age are found at Benicia, New Almaden, and between San Juan and Monterey.

On the south end of the Island of Yerba Buena, a section, 200 feet thick, shows the sandstone layers, varying from a few inches to six and eight feet, and alternating with beds of argillaceous slates and shales. All the weathered surfaces of this series of beds are of a rusty-brown or drab color, which extends throughout the rock to a depth of from ten to twenty feet, down to the limit of atmospheric influences. There are parts, however, of the upper beds that have not been reached and changed by decomposition; these parts are found in the condition of spherical or ellipsoidal masses, from which the weathered parts scale off in successive crusts. These nuclei have the appearance of great, rounded bowlders, and have accumulated, in great numbers, at the base of the cliff. They are of various sizes, but are smallest in the upper parts of the strata, near to the surface.

This spherical or globular condition does not appear to be the result of any peculiar arrangement of the material of the strata, a concretionary action, such as takes place in the igneous rocks, but is probably due to decomposition, the result of the absorption of infiltrating waters charged with impurities. A solid and homogeneous cube of sandstone thus exposed, under conditions favorable for absorption of the water on all its sides, would decompose most rapidly on the angles, producing a succession of curved surfaces gradually approaching a sphere.

The color of the sandstone is dark, bluish green, inclining to gray. It is exceedingly compact and tough, and does not break so readily as the fine-grained, red sandstone of the Connecticut river and New Jersey quarries.

* Explorations and Surveys for a railroad from the Mississippi river to the Pacific ocean, vol. v.

A section at Navy Point, Benicia, exposes a thickness of conformable beds of sandstone conglomerate and shales a little more than 1,000 feet in thickness. The strata are uplifted, being inclined at an angle of from 20 to 60 deg., and dipping toward the southwest. The trend of the outcrops is 75 deg. west of north, and the strata underlie, or rather form the hill upon which the government buildings are erected. The ridge of conglomerate is the hardest and most unyielding of all the strata, and its resistance to abrasion and atmospheric influences has determined the form of the hill and the shape of Navy Point. It is prominent at several points, along the surface of the ground, and is almost the only rock that appears above the soil in that vicinity. The bed is about twenty-five feet thick, and is composed of pebbles and gravel, very round, much water-worn, and chiefly derived from the wear of volcanic or eruptive rocks. Their colors are generally dark; and porphyries, agates and carnelians are abundant. Their average diameter does not exceed an inch, and many are about the size of beans and peas. They are closely united by a small portion of finer materials. The strata on both sides of the conglomerate consist of alternate beds of soft and friable argillaceous shales, with an occasional layer of gravel and pebbles.

The wide development of the formation, and the great thickness which it attains—probably 2,000 or 3,000 feet—and the even grain of the thick beds of sandstone over large areas, together with the remarkable uniformity of the strata, indicate that they were formed in a wide spread ocean or sea, and the thick beds of shale attest the depth and comparative quiescence of the water.

He found the Miocene rocks extending in a continuous belt along the base of the Sierra Nevada, from White creek to Ocoya creek and beyond it for many miles to the southward, forming high banks on both sides of Posuncula or Kern river, and even extending in a narrow strip to the Tejon.

Although by far the greater portion of the materials composing the formation are extremely light, fine and unconsolidated, there are, in some places, layers of sandstone and conglomerate, which offer more resistance to the action of the weather than the other strata, and that slightly modify the rounded contour of the hill sides. The principal constituent of the formation is a fine gray sand, mingled, in some of the beds, with a considerable portion of clay, and alternating with layers in which clay predominates. Volcanic materials, or sands derived from their abrasion, constitute a large part of the strata. Thick beds are formed almost wholly of white pumice stone, in rounded

masses, or in a fine powder, like fine sand, regularly bedded. The color of these beds is white, but the lines of stratification are rendered very distinct by the stains produced by the percolation of impure waters; also, by layers of the same ingredients, differing in their fineness, and by occasional seams of charcoal, in fragments. Thin layers of pebbles are also numerous, even among the strata of the finest materials. The inclined stratification, called diagonal stratification, is very common, and in many cases is beautifully shown by multitudes of the finest layers of sand, inclined in different directions.

He also identified this Group on Chico creek, in the valley of the Sacramento, at the foot of the Hills of the Sierra Nevada, on Carrizo creek, near San Diego, at Williamson's Pass, Los Angelos and San Pedro. Near Monterey it contains a bed of microscopic organisms, 50 feet in thickness ; and he supposed it to underlie the alluvium of the Colorado desert.

He described the Post-pliocene deposits of Monterey, San Pedro, and San Diego, and showed a comparatively recent elevation of the strata. The low hills around the bases of the mountains in the Colorado desert, and the elevation of the Coast Mountains, he supposed to be of the same age, because they are composed in great part of Tertiary strata, thrown into great wave-like flexures, with here and there a granitic axis of limited extent, but with serpentine abundant. In the auriferous regions, a similar serpentine abounds, and has in all cases the aspect of an intrusive rock. The movements which attended the uplift and plication of the Coast Mountains, must have affected the whole western slope of the Sierra Nevada. He expressed the opinion that the impregnation of the rocks with gold, and the formation of the Coast Mountains, were nearly synchronous.

He described, from the Miocene, at Point Lobos, near San Francisco, *Scutella interlineata*, and from a brown calcareous sandstone at Volcano Ridge, *Leda subacuta*, now *Nuculana subacuta*. Prof. Agassiz described, from Ocoya creek, at the western base of the Sierra Nevada, *Echinorhinus blakei*, *Scymnus occidentalis*, *Galeocerdo productus*, *Prionodon antiquus*, *Hemipristis heteropleurus*, *Carcharodon rectus*, *Oxyrhina plana*, *O. tumula*, *Lamna clavata*, and *L. ornata*. T. A. Conrad described, from the same locality, *Natica geniculata*, *N. ocoyana*, *Bulla jugularis*, *Pleurotoma transmontanum*, *Sycotypus ocoyanus*, *Turritella ocoyana*, *Colus arctatus*, *Tellina ocoyana*, *Meretrix decisa*, *Pecten nevadensis*, *P. catilliformis* ; from the San Diego Mission, *Cardium modestum*, *Corbula diegoana*, *Nucula decisa*, *Tellina diegoana*, *T. congesta*, *Mactra diegoana*, *Narica diegoana*, now *Vanikoro*

diegoana, *Crucibulum spinosum*, *Trochita diegoana*; from Monterey county, eighteen miles south of Tres Pinos, *Meretrix uniomeris*; from the Tulare valley, *Meretrix tularana*, *Arca microdonta*, *Purpura petrosa*; from Carmello, *Lutraria traskei*; from sixteen miles south of Tres Pinos, *Modiola contracta*, now *Volsella contracta*; from Carrizo Creek, *Pecten deserti*, and *Ostrea heermanni*.

He described, from the Post-pliocene at San Pedro, *Tellina pedroana*, *Saxicava abrupta*, *Petricola pedroana*, *Schizothœrus nuttalli*, *Mytilus pedroanus*, *Penitella spelœa*, *Nassa interstriata*, *N. pedroana*, *Oliva pedroana*, *Littorina pedroana*, and from Santa Barbara, *Crepidula princeps*.

W. P. Blake estimated the thickness of the Eocene, at the southern end of the Tulare valley, at 2,000 feet. The strata are chiefly argillaceous sandstone. T. A. Conrad described, from the Canada de las Uvas, *Cardium linteum*, now *Cymbophora lintea*, *Dosinia alta*, *Meretrix californiana*, *M. uvasana*, *Crassatella alta*, *C. uvasana*, *Mytilus humerus*, *Natica alveata*, now *Ampullina alveata*, *Turritella uvasana*, *Volutilithes californianus*, *Busycon blakei*, now *Perissolax blakei*, *and Clavatula californica*. It is quite likely that part or all of the strata referred to the Eocene from which these fossils were collected, belong to the Cretaceous.

He described,* from the Miocene, at Santa Barbara, California, *Janira bella*, *Mulinia densata*, *Arca canalis*, *A. trilineata*, *Axinœa barbarensis*; from Santa Clara, *Schizopyga californiana*; from Estrella valley, *Pallium estrellanum*, now *Lyropecten estrellanum*, *Spondylus estrellensis*; from Monterey county, *Pallium crassicordo*, now *Lyropecten crassicordo*, *Thracia mactropsis*, *Mya montereyana*, *Arcopagia medialis*, *Cryptomya ovalis*, *Cyclas tetrica*, *Dosinia alta*, *D. longula*, *Tamiosoma gregaria*, *Astrodapsis antiselli*; from San Raphael Hills, *Pecten meeki*, *P. altiplicatus*; from Santa Inez Mountains, *Pachydesma inezanum*; from Ranche Triumpho, near Los Angelos, *Lutraria transmontana*; from other places in California, *Arca congesta*, *Tapes linteatum*; and from Texas, *Mellita texana*.

Dr. Leidy described, from the Bad Lands of Nebraska, *Hipparion occidentale*, now *Hippotherium occidentale*, *Hyopotamus americanus*, *Leptauchenia decora*, *L. major*, *Leptochœrus spectabilis*, *Steneofiber nebrascensis*, *Ischyromys typus*, *Palæolagus haydeni*, *Eumys elegans*, *Amphicyon gracilis*, *Agriochœrus major*, *Enteledon ingens*, now *Elotherium ingens*, *Palæochœrus probus*, now *Perchœrus probus*;

* Proc. Acad. Nat. Sci., vol. viii.

from Bear creek, *Protomeryx halli;* from the Pliocene of Ashley river, South Carolina, and from the Miocene of New Jersey and Virginia, *Manatus antiquus, Phoca debilis;* from the Miocene of Cumberland county, Md., *Macrophoca atlantica,* now *Squalodon atlanticus, Sphyræna speciosa;* from North Carolina, *Orycterocetus cornutidens, Pliogonodon priscus;* from Salem county, New Jersey, *Chelonia grandæva;* from the Eocene of the Neuse river, North Carolina, *Ischyrhiza antiqua;* from Green river, Missouri, *Clupea humilis,* now *Diplomystus humilis;* from the Upper Tertiary of the Bijou Hills, on the Upper Missouri, *Merychippus insignis,* now *Protohippus insignis* and *Leptarctus primus.*

In 1857, Dr F. V. Hayden* made an estimated vertical section, showing the order of superposition of the different beds of the Bad Lands of White river, in Nebraska, referred to the Miocene, in ascending order as follows:

Bed A.—Light gray, calcareous grit, passing down into a stratum composed of an aggregate of rather coarse, granular quartz; underlaid by an ash-colored, argillaceous, indurated bed, with a greenish tinge. *Titanotherium* bed. Best developed at the entrance of the Basin from Bear creek. Seen also in the channel of White river. Thickness, 50 feet.

Bed B.—A reddish, flesh-colored, argillo-calcareous, indurated material, passing down into a gray color, containing concretionary sandstone, sometimes an aggregate of angular grains of quartz, underlaid by a flesh-colored, argillo calcareous, indurated stratum, containing a profusion of mammalian and chelonian remains. Turtle and Oreodon bed. Revealed on both sides of White river and throughout the main body of the Bad Lands. Thickness, 80 feet.

Bed C.—Light gray, siliceous grit, sometimes forming a compact, fine-grained sandstone. Seen on both sides of White river. Also at Ash Grove Spring. Thickness, 20 feet.

Bed D.—Yellow and light yellow, calcareous marl, with argillo-calcareous concretions, and slabs of siliceous limestone, containing well-preserved fresh-water shells. On the south side of White river. Seen in its greatest thickness at Pina's Spring. Thickness, 40 feet.

Bed E.—Yellowish and flesh colored, indurated argillo-calcareous bed, with tough argillo-calcareous concretions, containing *Testudo, Hipparion, Steneofiber, Oreodon* and *Rhinoceros.* Seen along the White river valley, on the south side. Thickness, 30 feet.

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* Proc. Acad. Nat. Sci., vol. ix.

Bed F.—Grayish and light gray, rather coarse-grained sandstone, with much sulphate of alumina (?) disseminated through it. Along White river valley, on the south side. Thickness, 20 feet.

Bed G.—Yellowish-gray grit, passing down into a yellow and light yellow argillo-calcareous marl, with numerous calcareous concretions, and much crystalline material, like sulphate of baryta. Fossils: *Hipparion*, *Merychippus* and *Steneofiber.* Bijou Hills, Medicine Hills, Eagle Nest Hills, and numerous localities on south side of White river, also at the head of Teton river. Thickness, 50 feet.

Bed H.—Gray and greenish-gray sandstone, varying from a very fine compact structure to a conglomerate. Bijou Hills, Medicine Hills, and Eagle Nest Hills. Thickness, 20 feet.

T. A. Conrad described,* from the Miocene, in Monterey county, California, *Mya subsinuata*; from San Pablo bay, *Pecten pabloensis*; from Santa Margarita, Salinas valley, California,† *Hinnites crassus*; from between La Purissima and Santa Inez, *Pecten discus*; from Santa Inez mountains, *Pecten magnolia*, *Tapes inezensis*, *Crassatella collina*, *Mytilus inezensis*, *Turritella inezana*, *T. variata*, *Natica inezana*; from Estrella valley, *Cyclas estrellana*, *Ostrea panzana*, *Glycimeris estrellanus*, *Astrodapsis antiselli*; from San Buenaventura, *Tapes montana*, *Perna montana*; from Pajaro river, Santa Cruz, *Venus pajaroana*; from the shore of Santa Barbara county, *Arcopagia unda;* from Sierra Monica, *Cyclas permacra*, *Ostrea subjecta*; from San Luis Obispo valley, *Arca obispoana*; from Salinas river, Monterey county, *Dosinia montana*, *D. subobliqua*; and from Gaviote Pass, *Mactra gaviotensis*, and *Trochita costellata*.

He described‡ from supposed Miocene strata at Rancho Helena, below Salado, *Ostrea veleniana*, and from Western Texas, in strata supposed to be Eocene, *Venus vespertina.* I am inclined to believe, however, that this is a Cretaceous species.

He described,§ from the Eocene of Alabama, *Calyptrophorus trinodiferus.*

Dr. Thomas Antisell‖ made the following section of the Miocene strata of California, viz:

1. Upper Miocene, consisting of bituminous and foraminiferous beds, trappean conglomerate, soft, yellow sandstone, foraminiferous layers and argillite beds. Thickness, 400 feet.

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* Expl. and Sur. R. R. Miss. Riv. to Pacific ocean, vol. vi.
† Expl. and Sur. R. R. Miss. Riv. to Pacific ocean, vol. vii.
‡ U. S. and Mex. Bound, Sur. vol. i.
§ Pro. Acad. Nat. Sci., vol. ix.
‖ Expl. and Sur. R. R. Miss. Riv. to Pacific ocean, vol. vii.

2. Middle Miocene, consisting of grits and calcareous sandstones, as at Panza and Santa Margarita. Thickness, 360 feet. And the San Antonia sandstones with Dosinia. Thickness, 250 feet.

3. Lower Miocene, consisting of the gypseous and ferruginous sandstones of Santa Inez, Panza, and Gavilan, containing *Ostrea*, and *Turritella*. Thickness, 1,200 feet. Total thickness of the Miocene, 2,211 feet, but part of this has since been referred to Eocene age.

He supposed that the elevation of the Coast Range, in California, above the water level, was an event much later in time than that of the Sierra Nevada. During the Eocene period, the latter range must have had its crest considerably above water, and was uplifted, finally, after the Miocene period ; but it is probable that during the whole of the Miocene period, the Coast Range was altogether beneath the sea level. Anterior to the Post-pliocene period, the erupted rock tilted up their strata, which, perhaps, did not reach the level of the ocean surface, and upon these smoothed edges, were deposited the unconsolidated clays and local drift. They had not, however, fully appeared above the surface of the ocean until the close of the Post-pliocene period. The elevated sea beaches found distributed over so large an extent of country, from north to south, at a level of from 100 to 150 feet above the sea, and containing species, all of which are now existing, show how comparatively recent is the final elevation of the lower lands of the State, and places the time of elevation of this range in the early portion of the Post-pliocene period. The plutonic rocks of the coast hills, also attest the comparative newness of the land ; pumice, obsidian, felspathic lava, trachyte, amygdaloidal greenstone, and serpentine. Volcanic rocks, of the latest kind, are those which are commonly distributed both in the form of axes and veins, or seams. Granite is also found, though not so extensive as a disturbing agent, or an elevator of a mountain ridge. When found in place, it is an older rock than those above mentioned, being cut through and injected by them, in many places ; but the granite, in the Coast Mountains, is a modern granite, being either highly felspathic, passing into leucite, and even trachyte in many places, or it is hornblendic, and passes into a hornblende porphyry ; micaceous granite is very sparingly distributed in Southern California. The elevation of the Coast Range must have taken place from two points, one in the north, and one in the south ; the latter force commencing in the southern part of San Luis Obispo, and the eastern part of Santa Barbara counties, and thence extending north ; as the upheaving force passed northward,

its power became spent, and unable to lift the imposed strata ; a similar action from the north, acting in a southerly direction with less vigor, produced an uplift, whose action ceased between latitude 37° and 38°. So that while the consolidated crust of the State was uplifted at each end, it was quiescent, or nearly so, in the middle ; and the two forces acting against each other may have produced a rupture of the superficial strata, and even a depression of the surface below the sea level, in which the waters of San Pablo, Suisun, and San Francisco, have taken their resting place.

Depressions of the strata and fissures from east to west across the line of the mountain ranges are common along the Pacific, north of this point, latitude 38 deg., and extend inland even east of the Sierra Nevada. In the course of these depressions rivers run. The Klamath and the Columbia are examples; which rivers might possibly never have emptied their waters into the Pacific, but for this fracturing effect produced by opposing volcanic forces.

The upheaval of the Coast Ranges have brought to view only Tertiary strata of the Miocene, and beds of clay of the Post-pliocene periods. These beds are thicker and more extensively distributed in a connected series than anywhere else on this continent, In this respect they rival or even excel the strata on the shores of the Mediterranean. It is interesting to trace the resemblance of form and outline of hills produced by similarity of geological circumstances, whether of formation or upheaval. Many of the scenes of California resemble those on the shores of northern Greece, Roumelia, northern Syria and the Calabrian peninsula.

There are no phenomena in California referable to the period of the polar drift or ancient alluvium, when the transport of large blocks or bowlders occurred. Over the extensive plains east of the Sierra Nevada, in Tulare valley, in the pleasant little oak valleys of the Coast Ranges, or on the terrace plains of the shore, not a single bowlder is to be met with—not a stone from which the plough might turn aside. This period, was, apparently, one of quiet in this State. Yet the mountain chains were elevated at this time. The topography was almost the same as at present, save the whole plain country was below the water level ; there were, therefore, elevated ranges from which the counties along the coast might have had scattered over their surface these blocks; but the Sierra Nevada has contributed no bowlders upon these plains, nor is there any stone included in the terraces which may not be classed as belonging to those ranges immediately bounding the deposit.

Not that the whole Post-pliocene epoch was passed without producing its effects: denudation on an extensive scale, lacustrine deposits, immense deposits of clay, sands, and gravels attest the long period alike of action and of repose which characterize the later Post-pliocene period, when the effects were more local, and every valley and plain had its beds of gravel and clay formed from its mountain margins.

Considerations founded on the zoological characters of the mollusks of the Miocene period of Europe, have led to the belief that the temperature of that epoch approached very much to that of Spain and Italy at the present time, or a mean temperature about 66 deg. Fahrenheit. As that temperature is almost the exact figure for a great portion of the area observed, it follows that there is little, if any, difference between the climate of the Miocene of Europe, and the present period in those places; and since the drift of California is local, and not general, and there are no traces on the surface of rocks exposed, of scratching or grooving, no moraines, no polished rocks (roches moutonnees), no traces of glacier action, perhaps it may be asserted with safety that the climate and temperature of this region, from the Miocene period to the present time, has preserved a constancy and equality, which latitudes more polar than 40 deg. never possessed.

Artesian boring through the Post-pliocene beds, in the Los Angelos valley, showed :

1. Alluvium, 6 feet.
2. Blue clay, 30 feet.
3. Drift gravel, 22 feet.
4. Arenaceous clay, 16 feet.
5. Tenaceous blue clay, 300 feet.

Such a thickness of deposit might be attributable to the local circumstances, namely, a deep trough in the sandstone strata under an elevation, almost vertical, close by ; yet that these incoherent beds are usually of great depth is evident from the smooth surface of the whole plain, which preserves its gradual slope from the Cordilleras to the ocean, independent of the dip or upheaval of the strata beneath. Again, when looking from the south entrance of the Cajon Pass toward San Bernardino, at an altitude of 2,000 feet, there may be perceived a broad terrace at the base of the mountain, consisting of loose conglomerates, gravel and clay beds, lying at an elevation nearly 200 feet above the present level of the plain in its neighborhood, and which are the only remains of a series of beds which have been removed from the lower and more exposed parts of the plain. Its average thickness, perhaps, might be about 200 feet; the other beds would preserve throughout a

pretty uniform thickness ; of these, bed 4, an arenaceous, yellow clay, is described as containing small marine shells. The brownish loamy clay (bed 1), is exposed by every creek, and in the sections produced by the Los Angelos river, several feet of the bluish clay (2) are exposed ; the beds are deposited almost perfectly horizontal, and are, therefore, unconformable to the soft sandstones of the San Pedro hills and the Sierra Monica, which in the former case have a dip of 20 deg., and in the latter are in places almost vertical ; they have, therefore, been deposited posterior to the upheaval of these soft Tertiary sandstones, and the surfaces have undergone no material alteration of contour since, the only change being that of elevation of the whole region out of the bed of the sea.

An investigation into the mineral nature of these various deposits shows that the alluvial covering, to the depth of six or seven feet, is aluminous in its finer parts, and granitic pebble in its coarser, and has been the result of the degradation of granitic and felspathic rocks. The soil of the plain is rarely quartzose, except when close to some of the low Tertiary hills, which alteration may therefore be due to the wash of these latter.

The blue clay is generally assigned by geologists to a slow deposit of mud, produced by the sifting action of the tide in estuaries or gulfs where matter is not transported by current actions ; it is the evidence of a calm condition of the waters during the period of deposit, and a cessation of upheavals of the land contiguous ; the two beds of bluish clay are separated by nearly forty feet of gravel and sand.

The drift gravel (bed 3) consists not only of rounded granitic pebbles, but also those of syenite, hornblende schists, metamorphic, brown sandstones, trap and amygdaloid ; and the underlying sandy bed is chiefly quartzose, and probably is the detritus of the sandstones at the base of the Cordilleras.

There have been no very large stones seen in the drift beds, there are no loose bowlders or erratic blocks, nor is there, either on the surface or in the deposits, any stone which can not be traced to masses of similar mineral constitution in the ranges bordering the plain. The period of general or polar drift, therefore, which was one of the earliest of the Post-pliocene epoch, passed by without affecting California ; and it was during the later periods of drift that the processes of wearing down continents and depositing them in the seas around took place, and were carried out on an immense scale, and over an immensely extended period of time.

Los Angelos plain is not the only one in California, where these de-

posits of clays and gravels are of great depth. The borings which have been made in Sacramento and San Joaquin plains have revealed a similar structure of basin, while that in Santa Clara valley, Santa Clara county, shows that the deposit has not been to so great a depth in that plain. Thus, at the Stockton well boring, after passing through red clays, sands, and gravel, the blue clay was met with at the depth of 400 feet. On the Sacramento valley, between the city and Pit river, the lava clays and sands cover the blue clay to the depth of 358 feet. In the Santa Clara valley, the covering of clay and light sand above blue clay is from 80 to 115 feet.

Blue clays are found 465 feet below the surface at Los Angelos, and, therefore, below the present sea level; while the surface of the terrace on San Bernardino is somewhat above 2,000 feet in altitude, and as the beds are horizontal, or nearly so, it follows that near Los Angelos the deposit took place when the water was over 2,000 feet deep at that point. All the low Tertiary hills were ledges of rock, several hundred feet below low water. The ocean then rolled up east of the Cordilleras, occupying the Colorado desert and the Mohave valley; and the Cordilleras stood up like a peninsula in the great mass of waters, with its crests from 3,000 to 5,000 feet above the surface, and with a breadth not more than 60 miles from S. W. to N. E. From the wearing down of the felspathic rocks, the granitic porphyries, and the dark colored shales, arose the blue clays, while the trappean and hornblende rocks formed the material of the coarser drift, transported by currents produced by the elevations. The carriage of such coarse matter would inevitably remove large portions of the Tertiary hills of the plain, and form the breaks which now occur in what was once a continuous chain, the denuded matter itself going to form the bed of arenaceous clay.

It has been calculated that the deposit going on at present in the Gulf of Mexico, produced both by the alluvium of the Mississippi and the transported mud of the Amazon, does not exceed more than half an inch yearly. There is nothing in the topographical condition of Southern California to warrant the belief that the slow deposit could have occurred to a greater depth in the same space of time; for there is no evidence of the double influence of a large river and a strong current of sea water coinciding. Admitting, however, that the same rate of deposit occurred then as now in the two localities, the period of deposit of the lower blue clay bed would be 7,200 years, and of the upper blue clay and gravels above 1,600 years, making a total of 8,800 years of perfect repose. If to this we add the periods of elevation, both rapid and slow, the total period occupied by the deposit of Post-

pliocene beds, would equal the period occupied by some deposits of the Secondary age. Yet such a calculation would scarcely give the total period accurately, since neither has the base of the lower blue clay yet been reached, nor should the present alluvial surface be looked upon as the last deposit of that epoch, or the prelude of the modern period; since, the slopes of San Bernardino display a series of conglomerates and gravels 200 feet above the level .of the nearest stream (Cajon creek). These are coarse accumulations of primary pebbles and granitic clays, which have been removed from every portion of the plain where it is exposed. In the gorges and canons it still remains ; and wherever a pass has been traveled, there it is found, as the superficial covering, between 200 and 300 feet deep ; this, the last evidence of deposit of the Post-pliocene period, has not been considered in calculation of duration. Yet such a deposit must have existed over the plain, and must have been removed afterward; so that two additional periods would still require to be added to make the calculation complete. namely, the period occupied by the last deposit, and the period occupied by its removal.

Prof. J. W. Dawson* said that the mountain of Montreal, in Canada, which rises 700 feet, forms a tide-gauge of the Post-pliocene sea, marking, on its sides by a series of sea cliffs and elevated beaches, the stages of gradual or intermittent elevation of the land as it rose to its present level. The most strongly marked of these sea margins, are at heights of 470, 440, 386, and 220 feet above Lake St. Peter, on the St. Lawrence, or 450, 420, 366, and 200 feet above the river at Montreal.

The highest of these beaches contains sea shells of existing species. Below the lowest, and at an elevation of about 100 feet above the river, spreads the great Tertiary plain of Lower Canada, everywhere containing marine shells, and presenting a series of deposits partly unstratified and partly assorted by water. In this vicinity, the regular sequence is as follows : 1. Fine, uniformly grained sand, in some places underlaid or replaced by stratified gravel. Marine shells in the lower part. 2. Unctuous, calcareous clay, of gray, and occasionally of brown and reddish tints. A few marine shells. 3. Compact, bowlder clay, filled with fragments of various rocks, usually, partially rounded, and often scratched and polished.

The thickness of these beds is at least 100 feet, of which the lower or bowlder clay constitutes the greater part, but the sand often attains

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* Can. Nat. and Geo. vol. ii.

the thickness of 10 feet, and the fine clay 20 feet. The City of Montreal is built upon this deposit. The bowlders are not confined to the bowlder clay, but are also found in the stratified clays and sand. The bowlders derived from the mountain, have been drifted to the southwest, in which direction they have been traced to the south shore of Lake Ontario, 270 miles distant. The terraces are best seen on the northeast side of the mountain. The rocks beneath the bowlder clay, are striated here S. 70° W. and S. 50° W. In some places the surface of the bowlder clay has been deeply cut into furrows by the currents which deposited sand and gravel upon it. In like manner the surface of the stratified clay, is sometimes cut into trenches filled by the overlying sand.

All the beds above referred to belong to the close of the Tertiary period, and they are all marine; but they may have been deposited at distant intervals of time, and in waters of very various depths and area. From the abundance of the *Saxicava rugosa* in the upper bed, it was named the Saxicava sand, and from the abundance of the *Leda portlandica*, in the middle bed, it was called the Leda clay.

Dr. Albert C. Koch* stated that he collected, in 1839, in Gasconade county, Missouri, about 400 yards from the bank of Bourbense river, where there was a spring, the remains of a Mastodon under such circumstances as to show that it had been burnt to death, and while undergoing this punishment had also been struck with bowlders and shot with arrows. The animal had evidently been mired as its legs were in an upright position with the toes preserved. The ashes was from 2 to 6 inches in thickness, showing that the fire had been kept up for a considerable length of time. In the ashes he found stone arrow heads, a stone spear head, and some stone axes. The whole was covered by strata of alluvial deposits consisting of clay, sand and soil from 8 to 9 feet thick. He also stated that about one year later he found another Mastodon which he called the "Missourium," in Benton county, under about 20 feet of alluvial deposits, and with the bones were several stone arrow heads, one of which lay underneath the thigh bone, and in contact with it.

[TO BE CONTINUED.]

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* Trans. St. Louis. Acad. Sci., vol. i.

NEW SPECIES OF TINEINA.

By V. T. Chambers.

GELECHIA.

1. G. goodellella, n. sp.

Allied structurally to *G. bilobella*, Zell ; and both species resemble *Nothris* in some respects. The palpi, in form, are almost exactly like those of *bilobella ;* the 2d joint is ochreous yellow; 3d, fuscus. Head and antennæ, dark, violaceous brown ; antennæ, subpectinate. Fore-wings, dark, golden brown, violaceous, with the dorsal margin from the base to a very small yellowish costal spot near the apex, is like polished steel; and before the middle of the wing length, this metallic hue spreads inward to the fold; and further back, behind the middle, it again spreads inward half way across the wing, where it narrows to a line, and crosses the wing to the dorsal cilia; on the fold, before the cilia, is a streak of the same metallic hue ; and around the apical margin, are five or six spots of the same hue, behind which is a narrow line of the general golden brown hue. Cilia, ochreous at their base, passing into brown about their middle, behind which they have a bluish cast ; underside, brown ; hind-wings, fuscus with paler cilia. Abdomen, brown above, silvery beneath, and tuft, ochreous ; anterior surfaces of legs, brown. *Al. ex.*, nearly 9 lines—a single female. Amherst, Massachusetts. Received from Mr. L. W. Goodell, in honor of whom I have named this fine species.

2. G. epigæella, n. sp.

Second palpal joint, brush-like ; hind-wings, emarginate beneath the apex. Dark, purple-brown. There is a white costal spot before the apex, and an opposite dorsal one on the fore-wings ; before these spots, the wing is flecked with a few minute white spots, the two largest of which are on the fold ; and there is another at the end of the cell. The costal white spot shows through the wing. Hind-wings and underside of both pair, fuscus. Head, white ; antennæ, dark brown. 2d joint of palpi, yellowish-white; 3d joint, dark brown, flecked on its upper surface with white; abdomen, fuscus, paler on top; legs, dark brown, annulate with white. A single male. *Al. ex.*, 9 lines.

Received from Mr. Goodell, of Amherst, Massachusetts, who informs me that the larva feed on *Epigæa repens*.*

3. G. CRESCENTIFASCIELLA, Cham.

This species was described from Texas. I have since taken a single specimen in Kentucky; and Mr. Goodell's collection contains three specimens from Massachusetts. The markings are much more pronounced on these three specimens than on any others that I have seen, and the whole insect is much darker. In one of the three the wing becomes almost black before the fascia, and is also much darker behind it, and all of them are marked with three or four small, brown spots on the disc, and one or two brown costal spots are distinctly margined behind with white. I have no doubt it is the same species: still it is a little remarkable that the northern and eastern specimens should thus be so much darker and more distinctly marked than western and southern ones.

Mr. Goodell's collection also contains *G. apicistrigella*, Cham., *G. roseosuffusella*, Clem., and *G. agrimoniella*, Clem., besides numerous species of the genus, some of which are probably new, whilst others appear to be old acquaintances, which, however, I am not now prepared to identify.

It contains also the following species not belonging to *Gelechia*, viz: *Incurvaria mediostriatella*, Clem., *Nothris eupatoriiella*, Cham., *Lithocolletis clemensella*, Cham., *Cosmopteryx gemmiferella*, Clem., *Dasycera nonstrigella*, Cham., *Dasycera newmanella*, Clem., *Œcophora argenticinctella*, Clem., *Butalis matutella*, Clem., and one or two other species of *Butalis* not identified. *Dryope murtfeldtella*, Cham., *Adela coruscifasciella*, Cham., which Lord Walsingham says is *A. ridingsella*, Clem., *Hyale coryliella*, Cham., *Batrachedra striolata*, Zell, *Anarsia trimaculella*, Cham., besides numerous other species that I have neither time nor opportunity to identify.

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* Since the foregoing remarks were written, I have received, from Mr. Goodell, specimens of the hibernating larvæ. From their size (less than half an inch long) as compared with that of the moth, I doubt if they are fully grown; they probably would feed again next spring. The head and next segment are dark stramineous, the anterior margin of the head, and the trophi being ferruginous; the posterior margin of the next (*prothoracic*) segment is dark brown, and it has a dark brown spot on each side. The remaining segments are pale stramineous or whitish, striped longitudinally with pink or reddish stripes; some specimens being much paler than others; there are the usual tubercular spots. The larvæ hibernate under a silken web, and in feeding, sometimes the side of a leaf is curled over, and sometimes several leaves are fastened together by the web.

GLIPHYPTERYX.

4. G. CIRCUMSCRIPTELLA, n. sp.

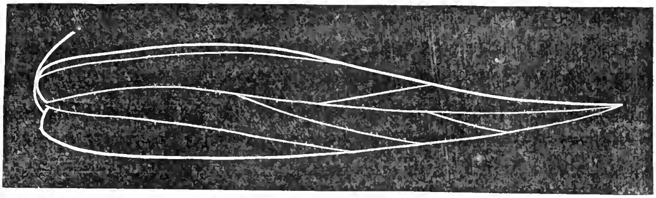
Differs decidedly from all the other species as yet known to me. The general hue is not very different from some others, being a dull, leaden or golden brown, according to the light. The large, white dorsal streak differs from that of the other species in not being curved; its hinder margin being nearly straight, and its anterior margin but little bent, so that the streak becomes a long, narrow triangle, with its base on the margin This streak is also rather wider than it is in the other species known to me: it extends nearly across the wing, its tip being opalescent; it is also but faintly or not at all dark margined. Behind it follow, at a little distance, two silvery white, costal streaks, almost perpendicular to the margin, and extending half way across the wing; and opposite to the space between them is a rather long, silvery dorsal streak, also perpendicular to the margin: each of these streaks is faintly dark-margined before, and is opalescent along its hinder margin. The apical patch is velvety black, and sends a process up to the tip of the second dorsal streak; this process, however, is interrupted by an opalescent spot, opposite to which on the dorsal margin is another opalescent spot. The apical black patch is margined above by a stramineous line, and contains a few short, stramineous lines and spots, and two small, opalescent spots. The cilia are brown; but about the middle of the apical margin in the cilia is a white streak, which curves around to the costal margin at the apical fourth of the wing length, and gives the wing the appearance of being decidedly falcate. On the costal margin behind the point where the curved streak reaches it, and near to the apex, is a triangular, costal, white streak, tipped with opalescent. There are thus only three costal streaks, or four including the curved line. The part of the wing above the apical patch is obscurely streaked with fine brown and whitish longitudinal lines. In some lights the golden brown parts of the wing become distinctly saffron yellow. Hind-wings, golden brown; abdomen, brown; palpi, white, flecked and annulate with brown. The form of the wings is about as in *G. haworthana*. *Al. ex.*, 6 lines. Amherst, Mass., Goodell.

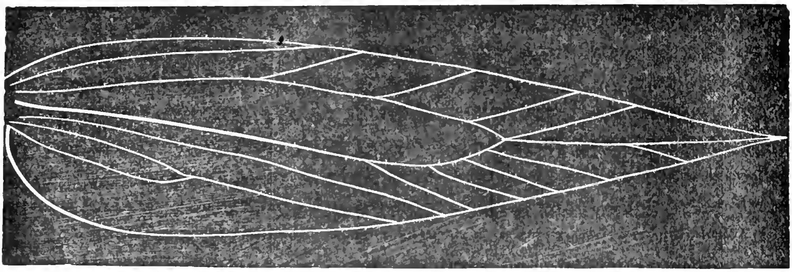
DOUGLASSIA.

5. D. (?) OBSCUROFASCIELLA, n. sp.

I have not the means of knowing whether the genus *Douglassia*, as defined in Ins. Brit. vol. iii., is still retained by European entomologists

or not, nor as to what disposition has been made by them of the species formerly referred to it. The species now before me does not in strictness belong in it, but is so near to it that I adopt the genus provision-





ally to avoid the necessity of establishing a new one. In this species the neuration is as shown in the figures 1 and 2; and in the fore-wings the subcostal and median veins each send four branches to the margin, instead of only three, as in *Douglassia.* The neuration is otherwise very near to that of *Douglassia*, and almost equally near to that of *Heliozella;* that of the hind-wings seems to be exactly that of *Heliozella æsella*, Cham. In ornamentation this species approaches *Douglassia* more nearly than *Heliozella*, or any of the other small species of *Gliphypterygidæ* known to me. The colors are plain, and there is no white spot on the dorsal margin of the fore-wings. The head is smooth; face, broad; antennæ, simple, more than half as long as the fore-wings, with small basal joints; tongue, short and naked; maxillary palpi, rudimentary; labial palpi, short porrected : 2d joint with spreading scales; 3d joint small, also with spreading scales; eyes, small, globose.

The insect is brown, faintly dusted with white; fore-wings, pale at base, then about the middle there is a wide, darker brown fascia, followed by a paler fascia, behind which to the apex the wing is again darker, with a roundish, darker patch about the end of the cell. Cilia, fuscus, with a dark brown hinder marginal line at their base; hind-wings, fuscus; antennæ, with brown and sordid yellowish annulation; *Al. ex.*, nearly 4 lines. Amherst, Goodell.

LAVERNA.

6. L. ŒNOTHERÆVORELLA, n. sp.

This is the fifth species of this genus that is known to feed on *Œnothera* in this country, while in Europe four species feed on the allied *Epilobium*, and one on *Circeœa*. Ten species, therefore, are known to feed on three genera of the *Onagracœa*. A much larger number of species, however, feed on plants of various other families. This is a very plain species. The 2d palpal joint, is clavate ; the 3d is also a little enlarged, and the wings are without tufts of scales. The color is a sordid, yellowish-white, sparsely flecked with fuscus scales on the disc of the fore-wings; but more densely along the costal margin and apex ; there is a fuscus spot on the fold, and one on the disc; and the cilia are fuscus ; hind-wings, fuscus. Stalk of antennæ, brown ; the basal joint, head and thorax, sordid, yellowish-white, except the tip and the under surface of the third palpal joint, and outer surface of the basal portion of the second joint, which are of the general whitish hue ; sometimes the apical dusting forms a line through the apical part of the wing. *Al. ex.*, over 6 lines. Its nearest American congener, is, perhaps, *L. œnotheræseminella*, from which, however, it differs widely. *L. œnotheræseminella* is much nearer to the European species, *L. phragmitella*, which feeds on *Typha*, and not on any of the *Onagracœa*. Amherst, Goodell.

7. L. (?) QUINQUICRISTATELLA, n. sp.

Dark, bronzy-brown, with greenish or golden reflections. Tips of antennæ, and the palpi, white. The palpi are slender and rather short for this genus. Face, with a metallic lustre. Legs, dark brown, annulate with white. On the fore-wings, at about the basal fourth of their length, on the disc, are two large tufts of the general hue, placed opposite and almost touching each other, and extending almost to both the costal and dorsal margins ; further back, behind the middle, are two other equally large tufts similarly placed, and of a pale, straw color ; and further back is a single large tuft, of the same stramineous hue. *Al. ex.*, about 5 lines.

The antennæ are but little more than half as long as the wings. In the single perfect specimen before me the wings are not spread, and I have not examined the neuration. It is, perhaps, not a true Laverna, but in the present state of that genus, I think it best to place this species in it. Amherst, Goodell.

8. L. MINIMELLA, n. sp.

The *Lavernæ*, that is species which are allied to *Laverna* proper, and which for want of a better location, we at present place in *Laverna*, do not form an altogether homogenous group. Such species, as 5-*cristatella* above, and *L. gleditschiæella* differ structurally, as well as in the presence of tufts on the wings of 5-*cristatella*. Other species have the palpi much thicker, or clothed with spreading scales, and wide differences prevail in their ornamentation. 5-*cristatella* and *gleditschiæella*, are dark, bronzy-brown; others, as *L. sabalella*, Cham., are yellowish, with a silky lustre; others are white, marked more or less with yellowish; others as *Œnotheræseminella*, are mainly ochreous, and others as *L. murtfeldtella*, have the basal part of the wings white, with the remainder ochreous, mottled with brown, and with scales of other colors. But with all this variety, and with considerable differences in the forms of the wings, and size of the antennæ, there is yet a remarkable agreement among them in the character of the neuration of the wings. There are also great differences in the size of species.

This small species, as to ornamentation, belongs to the same group with the European *L. propinquella*, and our *murtfeldtella*, except that its wings are not clothed with tufts of scales, and the neuration of the wings is very similar to that of *L. staintoni*, as figured in Ins. Brit., vol. iii., but the wings are narrower.

Head and palpi, white; antennæ, brown; legs, sordid whitish, marked with brown on their anterior surfaces. Basal third of the fore-wings white, stained with fuscus along the fold, and bordered behind on the costal margin by a dark brown line, which extends half way across the wing, thence to the tip the wing is yellowish ochreous, with short but distinct brownish, costal streaks, opposite to the second of which, but scarcely touching the dorsal margin, is a brown streak, concave toward the base of the wing; there is a blackish, longitudinal line in the middle of the apical part of the wing; costal and apical cilia, white; dorsal cilia, fuscus, three hinder marginal brown lines in the costal and apical cilia, placed respectively at their base, middle and tip. *Al. ex.*, one fourth inch or a little more. Amherst, Goodell.

ELACHISTA.

9. E. ALBAPALPELLA, n. sp.

Palpi, white; head, antennæ, and fore-wings, brownish. The palpi are slender, and if recurved would reach the vertex. Before the middle

of the fore-wings is a rather wide, irregular, white fascia, a little nearer to the base on the costal than on the dorsal margin; before the apex is a dorsal white spot, and opposite, but a very little behind it, is a costal one, which almost joins it in the middle of the apical part of the wing. Extreme apex, white, with a dark brown, hinder marginal line behind the white; cilia, pale grayish. The basal part of the wing, to the fascia, is paler than the remainder of it; dorsal cilia, fuscus; hind-wings and their cilia, fuscus; abdomen, purplish brown. *Al. ex.*, 3 lines. Amherst, Goodell. It belongs to the same section with *E. præmaturella*, Clem. The Kentucky species which I formerly mistook for *præmaturella*, and which is very near to it, is however a different species from *præmaturella*, differing from it in the neuration.

GRACILARIA.

10. G. ACERIELLA, n. sp.

Very different from *G. packardella*, Cham. and *G. acerifoliella*, Cham., which feed on maple, and more like *strigifinitella*, Clem., or *12-lineella*, Cham.; but it is still nearer to *G. juglandisnigræella*, Cham. Indeed, it seems to differ from this latter species chiefly by being a little smaller, by having the tips of the palpi white, and the disc of the fore-wings more obscurely flecked with white scales, while the dorsal margin and cilia are more distinctly so; and there is a series of small, white, costal spots ; or rather *the costal margin from the apical third of its length is* white, divided into a series of spots, by about eight fine brown lines, and the cilia are divided by two white lines. As in *juglandisnigræella*, the ground color is a dark, blood brown. The face and palpi are white; the palpi, flecked or annulate with brown, and the basal half of the posterior femora is white; abdomen, brown, with the anal tuft and under surface, pale stramineous. A single male, which Mr. Goodell informs me was bred from maple leaves.

The collection contains also, *G. superbifrontella*, Clem., *G. packardella*, Cham., *G. erigeronella*, Cham., *G. rhoifoliella*, Cham. (I find that I have sometimes carelessly written this *G. rhoisella*), and *G. pulchella*, Cham. It contains also an *Ornix*, which may be *O. inusitatumella*, Cham. But it is useless to attempt to separate some of the species of *Ornix* without authentic specimens to compare with, and I have none of this species now.

OPOSTEGA.

11. O. NONSTRIGELLA, n. sp.

This appears to differ from *O. 4-strigella*, Cham.; only in the absence of the four costo and dorso apical streaks. The stalk of the antennæ is sordid stramineous ; the eye caps, head, palpi, thorax and fore-wings are white. It has the oblique fuscus spot on the dorsal margin of the fore-wings, the fuscus apex and black apical spot. Size as in *4-strigella.*

The American and English species form a close natural series. The English *salaciella* has no spots on the wings; *albogalleriella* has only the apical spot; *nonstrigella* has the fuscus spot on the dorsal margin, and the fuscus apex in addition to the apical spot; *auritella* (English), in addition has three fuscus streaks in the cilia ; *4-strigella* has four fuscus streaks in the cilia; as also has the English *crepusculella*, but differently placed. There are, however, other minute differences. It is to be hoped that somebody will, one of these days, find an *Opostega* larva. It is said that one was once found in Europe.

A PRE-HISTORIC CUP MADE FROM A HUMAN CRANIUM.

By EDGAR R. QUICK.

A somewhat remarkable and possibly unique specimen of aboriginal handicraft, has been recently exhumed by some curiosity-seeking boys, near Cedar Grove, Indiana, a small town situated on the Whitewater, about thirty-seven miles northwest of Cincinnati. On the 10th of October, 1880, they discovered a human skeleton, and with it, instead of the earthen pot so often found with such remains, was a cup or bowl, made from a child's skull.

The skeleton, as described to the writer by one who assisted in taking it out, was in a sitting position, facing northwest, with the vessel at the left side on a level with the hips. The bones of the right hand and arm were missing, but I think had fallen with earth into a gully which had washed out on that side. The skeleton, which is that of an old and rather tall man, is in a fair state of preservation.

The vessel, or drinking cup, is, evidently, from its small size and

plainly marked sutures, the skull of a child. The base of the skull has been roughly cut away and scraped smooth, leaving an irregular margin or rim to the vessel. Both the inner and outer surface has been scraped with some rough-edged tool, leaving numerous scratches. Two holes were drilled through the side, near the upper part of the cup, for the purpose of mending a crack by tying the fractured parts together. A portion of the frontal bone was accidentally broken away by a stroke of the spade. This curious relic of barbarism is now in the collection of the writer, as is also the well-preserved skull with which it was found. Along the gully before mentioned, and within a few feet of these remains, were found parts of three other skeletons.

It may be added that the place where they were found, has for many years been known to be an aboriginal cemetery.

The situation is on the highest terrace formation, about one hundred feet above and immediately overlooking the Whitewater. The soil is compact clay, about two feet thick, overlying clean, white sand, in which the bones were found.

THE MAMMALIA OF THE VICINITY OF CINCINNATI, —A LIST OF SPECIES WITH NOTES.

By Frank W. Langdon.

So far as the writer has been able to ascertain, no distinctively local list of "Ohio" Mammals has ever appeared, while in the forty-two years that have elapsed since the publication of the only general list extant,* numerous noteworthy changes in our Ohio mammalian fauna have undoubtedly occurred. The following list is offered, therefore, as a contribution to the natural history of this vicinity, with the hope that it may be a step toward the attainment of a more definite knowledge of the distribution of that important class of animals within this and neighboring States.

The limits herein assigned to the "Vicinity of Cincinnati," correspond with those recognized by the writer in his "Revised List of Cincinnati Birds,"† namely, the valleys of the two Miamis and the Whitewater within ten miles of the Ohio river: in the few cases where

* See "Report on the Zoology of Ohio," by Prof. J. P. Kirtland, M.D., in Second Annual Report on the Geological Survey of Ohio, Columbus, 1838, pp. 157-200. The list of mammals is a nominal one of fifty species, three of which are synonyms, and a fourth, the European *Arvicola amphibus* is included either through misinformation or error in identification. Short notes on thirty-three species are given in an appendix entitled "Notes and Observations."

† This Journal, Volume i., No. 4, January 1879, pp. 167-193.

it has been thought proper to exceed these limits the localities are expressly stated.

For valuable notes and observations contained in the present paper, acknowledgments are due to Dr. R. M. Byrnes, our worthy President; to Messrs. John W. Shorten, and Charles Dury, the well known taxidermists of Cincinnati; and to Mr. Edgar R. Quick, of Brookville, Indiana,* an enthusiastic naturalist and reliable observer, who has contributed largely to the present knowledge of our local fauna.

An important feature of this list, is the positive record of several now extirpated species, whose former occurrence in this vicinity has heretofore been merely inferred; these have been fully identified from their remains found, well preserved in ashes, during the excavations conducted by the Literary and Scientific Society of Madisonville, Ohio, in a pre-historic cemetery, near that place; an account of these explorations is now appearing in this Journal.† Some of these records are of especial interest as regards extension of the known range of the species; and others as furnishing actual evidence of the changes continually occurring in our fauna.

Supplementary lists are given of species not yet identified, whose known range includes this locality, and of extinct species whose fossil remains have been found in Ohio.

The general arrangement adopted corresponds with that of Prof. Jordan's "Manual of the Vertebrates of the Northern United States;" but Dr. Coues' "Fur-bearing Animals," and the elaborate "Monographs of North American Rodentia," by Coues and Allen, and of North American "Chiroptera," by Drs. Coues and Yarrow, have been followed in the classification and nomenclature of the orders of which they treat.

A.—LIST OF IDENTIFIED SPECIES.

Class MAMMALIA.

Sub-class MONODELPHIA: PLACENTAL MAMMALS.

Order A.—CARNIVORA: *Flesh-Eaters.*

Family I.—FELIDÆ: *The Cats.*

1. LYNX CANADENSIS, Rafinesque.—*Canada Lynx.*—Identified from a nearly entire skull and other portions of the skeleton, found in the

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* About forty miles N. W. of Cincinnati.

† This Volume, pp. 40-68; 128-139.

Madisonville ancient cemetery. This and the succeeding species are now exceedingly rare, if not entirely extirpated, in Ohio.

2. Lynx rufus, Rafinesque.—*American Wild Cat.*—Remains identified in company with those of the preceding species. Mr. Quick notes its capture, within thirty years, near Brookville, Indiana ; and Dr. Haymond mentions it as "rare," in his list of the Mammals of Franklin county, Indiana.*

Family II.—Canidæ : *The Dogs.*

3. Canis lupus, Linnæus.—*Wolf.*—Identified from remains found in the Madisonville ancient cemetery.

4. Canis latrans domesticus. — *American Dog.*— Canine crania, showing marked shortening, and other evidences of domestication, are of frequent occurrence in the Madisonville ancient cemetery. Adopting Dr. Coues' view† of the ancestry of the aboriginal dogs of North America, this animal may be designated as above. The name might very properly be objected to, however, on the ground that our Common Wolf (*C. lupus*) would probably be as susceptible of domestication as the Coyote, and in this region was more likely to have been the animal selected.

5. Vulpes vulgaris pennsylvanicus, Coues.—*Red Fox ; Cross Fox; Silver Fox ; Black Fox.*—(These various common names indicate only local, geographical or accidental variations in the same species.) Still a resident in limited numbers, within a few (6 or 8) miles of Cincinnati; and several instances of its capture during the past ten years are known. A nearly complete skull has been found *in the ash-pits of the Madisonville ancient cemetery.* This fact is of importance as controverting the theory that the Red Fox is exclusively an introduced species, imported by early Virginian settlers from Europe, as the interments in this cemetery undoubtedly antedate the settlement of Virginia, and are believed by many to be pre-Columbian.

6. Urocyon cinereo-argentatus (Schreber), Coues.—*Gray Fox.*— Two or three nearly complete crania, recovered from the "ash-pits" in the Madisonville ancient cemetery. The Gray Fox is still probably of occasional occurrence in this region, though, as far back as 1838, Prof. Kirtland speaks of its rapid disappearance before advancing civilization, and its general replacement by the Red Fox.

* Indiana Agricultural and Geological Reports, 1869, p. 203.

† *Vide* American Naturalist, vol. i., 1867, p. 289, *et seq; Ibid* 1873, p. 385. These papers are abstracted by Drs. Coues and Yarrow in chapter 2, volume v., of Wheeler's Surveys west of the 100th Meridian, pp. 44-51.

Family III.—Mustelidæ: *The Weasels.*

7. Putorius erminеus, Cuvier.—*Common Weasel, Ermine.*—A rather common species, its small size and nocturnal habits protecting it from extermination, while the abundance of domestic poultry, and of rats, mice, etc., is exceedingly favorable to its maintenance and increase.

8. Putorius vison (Schreber), Richardson.—*American Mink.*—A rather rare species, partly, no doubt, on account of the market value of its fur. Half grown young taken at Madisonville, June 12, by my brother, Mr. C. C. Langdon.

9. Mephitis mephitica (Shaw), Baird.—*Common Skunk.*—Numerous remains found in the "ash-pits" of the Madisonville ancient cemetery, and the species is far from rare in that vicinity at the present day. The individual variation in this species with respect to "pattern" of coloration, is a subject of frequent remark: specimens illustrating this peculiarity are in the Society's Museum.

10. Lutra canadensis, Kerr.—*American Otter.*—Mr. Dury favors me with a note of the occurrence of this species near Venice, Butler county, Ohio, several years ago. Prof. Kirtland, in 1838, alluded to it as "still common" in Ohio; and more recently, Dr. Haymond includes it in his list of Mammals of Franklin county, Indiana (1869), though he states that he has "seen none" * * * for "many years." It should now probably be classed amongst the extirpated species of this vicinity.

Family IV.—Ursidæ: *The Bears.*

11. Ursus americanus, Pallas.—*Brown, Black,* or *Cinnamon Bear.*—Remains abundant in the "ash-pits" of the Madisonville ancient cemetery. Mr. Quick's collection contains a skull of this species, which was found with the remainder of the skeleton in a hollow tree near Brookville, Indiana, several years ago; and Dr. Haymond mentions a specimen seen in Franklin county, Indiana, about the year 1840.

Family V.—Procyonidæ: *The Raccoons.*

12. Procyon lotor, Storr.—*Common Raccoon.*—Still a common species in this vicinity, although seemingly scarce on account of its nocturnal habits. The abundance of its tracks along all our streams, where it searches for cray fish and other aquatic animals, is sufficient evidence of its numbers. I have twice caught this species in steel

traps baited with shelled corn, which I had set in shallow water for wild ducks. Numerous remains occur in the Madisonville "ash-pits."

Order B.—UNGULATA: *Hoofed Animals.*

Family VI.—CERVIDÆ: *The Deer.*

13. CERVUS CANADENSIS, Erxleben. — *Wapiti.*—(Improperly called "American Elk," which name should be applied only to our "Moose," *Alce americanus*).

Formerly a rather common resident, judging from the abundance of its remains in the Madisonville ancient cemetery. The antlers of this species were evidently considered valuable property by the pre-historics, on account of their availability in the manufacture of various useful and ornamental articles, and are found carefully laid away in the ash-pits with the other valuables of the deceased; among the numerous articles made from them are two which have apparently been used as *plows.*

14. CARIACUS VIRGINIANUS, Gray. —*Virginia Deer.* — The crania, antlers and other remains of this species also have been found in large numbers in the ancient cemetery above referred to; from the lower fore leg bones (metacarpals) of this and the preceding species were manufactured the curious implements figured on plates 1 and 2 of this Volume. The species is still a resident of northern Ohio, and has been noted as far south as Mercer and Auglaize counties within the past six or eight years.

Order C.—CHIROPTERA: *The Bats.*

Family VII.—VESPERTILIONIDÆ: *Ordinary Bats.*

15. ATALAPHA NOVEBORACENSIS, Coues.—*Red Bat.*—With the exception of the Little Brown Bat (*V. subulatus*), this is our most common representative of the family. On July 18, 1877, Mr. Wm. H. Whetsel, of Madisonville, Ohio, brought to me a female of this species, which he had found hanging under an apple tree limb, during a hard shower, holding between its wings three half grown young which were barely able to fly.

16. ATALAPHA CINEREUS, Coues.—*Hoary Bat.*—A specimen now in the Society's Museum was taken near Cold Spring, Kentucky (three or four miles from Cincinnati). about six years ago. It is probably a very rare species in this vicinity, being rather northerly in its distribution and nowhere common so far as known.

17. Vespertilio fuscus, Beauvois.—*Carolina Bat; Dusky Bat.*—Much less common than the Red, though not nearly so rare as the Hoary Bat. Specimens taken in Cincinnati by Mr. J. W. Shorten, and at Madisonville by the writer.

18. Vespertilio subulatus, Say.—*Little Brown Bat.*—Our most common species, and said to be "abundant everywhere" in North America (*Jordan*). Dr. Coues states that "of the present species, as many as ten thousand, by actual count, have been destroyed in one building alone."*

Order D.—Insectivora: *Insect-Eaters.*

Family VIII.—Talpidæ: *The Moles.*

19. Scalops aquaticus, Fischer.—*Common Mole.*—Too common for the welfare of our lawns and kitchen gardens in many neighborhoods. In a remarkable albinotic specimen in the writer's collection, taken at Madisonville, the basal five sixths or more of the pelage is pure, snowy white, the extreme tips of the hairs being nearly normal in color. Specimens showing orange-colored spots or streaks on the ventral surface, and about the mouth, are of somewhat frequent occurrence.

20. Scapanus americanus (Harlan), Coues.†—*Hairy-Tailed Mole; "Black Mole."*—I purposely transgress our limits at this point in order to note the capture of this species near Rome, Adams Co., Ohio, on May 19, 1877, by Mr. J. W. Shorten, to whom I am indebted for the specimen. This is the most southern record for the species of which I am aware, and the third specimen known from Ohio; the first two specimens, taken near Cleveland, are mentioned by Professor Baird in his "Mammals of North America" (Vol. viii., P. R. R. Reports, pp. 68-70). Mr. Shorten informs me that it is not a rare species in Adams county, where it is known by the local name of "the black mole."

Family IX.—Soricidæ : *The Shrews.*

21. Blarina brevicauda, Baird.—*Mole Shrew.*—Our most common representative of the family, inhabiting galleries in woods under the fallen leaves. Unlike the mice, the members of this family do not hibernate during the winter, but on the contrary are then exceeding-

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* Coues and Yarrow. Report upon the Collections of Mammals, etc., in vol. v. of Wheeler's Survey, west of the 100th Meridian, Washington, 1875, p. 98.

† See American Naturalist, March, 1879, p. 190, for correction in current nomenclature of this species, by Dr. Coues.

ly active, and with a light snow on the ground they may be easily traced by their tunnels or galleries which resemble miniature "mole-hills."

22. Blarina (sorisciscus) parva (Say), Coues.—*Little Shrew.*—Two small Shrews from Brookville, Indiana, sent to me by Mr. E. R. Quick, are pronounced by Dr. Coues to be the long-lost "*Sorex parva*" of Say, which has been known, heretofore, only by his original description in 1826. Under date of January 15, 1879, Dr. Coues favors me with the following communication in regard to it: "'*Sorex parvus*, Say,' has never been identified, but for years has been kicked about promiscuously among all the North American species of the family. It is unquestionably a *Blarina*, likewise a *Sorisciscus* (30-toothed), and I have not the slightest doubt that you have the veritable animal of Say in the specimen you send."

Mr. Quick informs me that it is rather common near Brookville, inhabiting the open fields; and I have since taken a third specimen at Madisonville, in December, 1878.

Order E.—Rodentia: *Rodents or Glires.*

Family X.—Sciuridæ: *The Squirrels.*

23. Sciuropterus volucella, Geoffroy.—*Common Flying Squirrel.*—A rather common species, inhabiting deserted Woodpecker holes and similar places, generally in open woods or about clearings. It is nocturnal or crepuscular in its habits, and is said to be very easily domesticated. I am indebted to Mr. Wm. H. Whetsel, of Madisonville, Ohio, for a female and three young of this species, taken by him from a hole in a haw tree within easy reach from the ground, on September 7, 1877: the eyes of these young at the date mentioned, were not yet opened.

24. Sciurus hudsonius, Pallas.—*Red Squirrel; Chicaree.*—Included by Dr. Haymond in his list of the "Mammals of Franklin county, Indiana" (1869), on the strength of a single specimen. At the present day it occurs very rarely, if at all, in this vicinity, though quite common in Mercer and Auglaize counties, about 130 miles north of Cincinnati.

25. Sciurus carolinensis, var. carolinensis, Allen.—*Southern Gray Squirrel.*—A common species, though quite variable in numbers from year to year in the same locality; this variability is presumed to be due to its irregular migrations in search of food, and although I

am not aware that these local migrations have been actually observed in this vicinity, it is a matter of common observation that a deficiency in the mast crop indicates a scarcity of squirrels, and *vice versa.*

As would be expected in a locality occupying a position almost on the boundary line of the two sub-species (*carolinensis* and *leucotis*), a large majority of the specimens from this vicinity can not be positively referred to either form, being intermediate both in size and coloration. As illustrative of this fact, the lengths (from nose to root of tail) of a series of nine specimens taken near Cincinnati on September 30, 1880, by my colleagues, Drs. S. M. Hart, and G. M. Allen, are appended. In the general extension of the yellowish-brown tinge over the entire dorsal surface, most of these specimens more resemble *carolinensis* than *leucotis*, while in two or three of the larger ones this tinging is almost absent, the back presenting the clear, gray appearance characteristic of *leucotis*, with the brownish limited to the median dorsal line. Their lengths are as follows, in inches: $10\frac{1}{8}$, $10\frac{1}{8}$, 10, 10, 10, 10, 10, 10, 9; average $9\frac{11}{12}$.

Judging from specimens taken at Madisonville in October, I have good reason for believing that the species litters in this latitude as late as September 15-30.

25*a*. SCIURUS CAROLINENSIS, var. LEUCOTIS, Allen.—*Northern Gray Squirrel.*—Specimens answering closely to Allen's description ot this form are of occasional occurrence here. As the general tendency however, of Cincinnati specimens seems to be toward *carolinensis*, the notes on the species have been given under the head of that variety.

The Black Squirrel, now generally considered to be a melanotic phase of var. *leucotis*, has never, to my knowledge, been observed here, though said to be of rather frequent occurrence in central and northern Indiana.

26. SCIURUS NIGER, var. LUDOVICIANUS, Allen.—*Western Fox Squirrel.*—A somewhat rare species in this vicinity, though quite common in the central and northern portions of the State. Dr. Haymond* states that the Fox Squirrel made its first appearance in the vicinity of Brookville, Indiana, about the year 1840, and has since gradually increased in numbers.

27. TAMIAS STRIATUS, Baird.—*Chipmunk; Ground Squirrel.*—A very common species, and a troublesome forager on newly planted corn fields in some localities.

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* *Vide* Indiana Agricultural and Geological Reports, 1869, p. 205; article, "Mammals of Franklin county."

28. Spermophilus tridecimlineatus,* Audubon and Bachman.—*Striped Gopher.*—Identified in the summer of 1862, by Dr. R. M. Byrnes, near Middletown, Butler county, Ohio, where it inhabited a small tract of original prairie in considerable numbers. Dr. Byrnes informs me that the several specimens taken by himself and others, were obtained by filling their burrows with water and capturing them as they came out.

Several specimens "planted" by Mr. Dury near Avondale a few years since, did well, he informs me, for a while, but were finally destroyed by cats.

The experience of the agriculturists about Tuckerton, N. J., where a single pair of an allied species (*S. franklini*), was accidentally introduced in 1867, does not speak in favor of their naturalization here or elsewhere. So prolific were they that the descendants of this single pair during the next ten years had spread over an extent of country thirteen miles in length and of indefinite breadth, in such numbers as to render them a farm pest by reason of their fondness for young poultry and the numerous burrows they made in the fields.† The present records of *S. tridecimlineatus* are its only ones in Ohio, with the exception of that of Prof. Kirtland, who referred to it as found only in the northwestern parts of the State, "and there not very common."‡

29. Arctomys monax, Schreber.—*Woodchuck; Ground Hog.*—Not very rare in this vicinity, though it can not be classed as common; makes its burrows in steep hillsides and the bluffs bordering our smaller streams, affecting especially the southern exposures.

Numerous remains recovered from the Madisonville ancient cemetery.

The fact that this species is to some extent arboreal in its habits seems to have been overlooked by writers generally. I have myself had the pleasure of witnessing one descend the perpendicular trunk of a large sugar maple, *head first*, and make immediately for its burrow situated about ten feet distant in the face of a bluff; when first noticed

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* Since the present article has been in type, I have received, through the kindness of Dr. J. M. Wheaton, of Columbus, O., proof sheets of Dr. A. W. Brayton's forthcoming Report on the Mammalia of Ohio (Ohio Geol. Survey, iv.), in which I find myself given as authority for the occurrence of *Spermophilus franklini* in this State. This is an error for which I am personally and solely responsible, having misinterpreted Dr. Byrnes' description of the animal at the time of sending the note to Dr. Brayton. Subsequently a more detailed description from Dr. Byrnes revealed the fact that the animal was *S. tridecimlineatus*, but by some oversight on my part, Dr. Brayton was never notified of the correction; his remarks on *S. franklini*, therefore, so far as they relate to Ohio, should be referred to *S. tridecimlineatus*.

† *Vide* "Monographs of North American Rodentia," by Coues and Allen, pp. 883-884.

‡ Second Annual Report on the Geological Survey of the State of Ohio, 1838, p. 177.

it was about thirty feet from the ground. I have also had reported to me the fact of its sunning itself ten feet from the ground in a small dogwood tree, which was observed by R. O. Collis, Esq., of Madisonville, Ohio, to whom I am indebted for the information.

Family XI.—Castoridæ: *The Beavers.*

30. Castor fiber, Linnæus.—*Beaver.*—Formerly abundant, as attested by early observers and also by its numerous remains brought to light during the excavations in the Madisonville ancient cemetery. Mr. Quick notes it on the Whitewater on the strength of a molar picked up amongst the alluvial gravel, near Brookville. Very few, if any, now exist in Ohio, the names of "Beaver Creek," "Beaver Dam," etc., alone remaining as monuments to the memory of the species. Hildreth* mentions specimens trapped on the Muskingum as late as 1805.

Family XII.—Muridæ: *The Mice.*

31. Mus decumanus, Pallas.—*Brown* or *Norway Rat.*—Our common species, introduced into America about the year 1775 (*Jordan*). Our first record of it in this vicinity is that of Dr. Haymond, who states that it made its appearance at Brookville, Indiana, "in the summer of 1827."†

32. Mus rattus, Linnæus.—*Black Rat.*—"Introduced (into America) about 1544, but now being supplanted by the preceding" (*Jordan*). I do not remember to have seen a specimen for several years but presume that it is still of occasional occurrence in this vicinity. Dr. Haymond includes it in his list of the Mammals of Franklin county, Indiana (1869).

33. Mus musculus, Linnæus.—*Common House Mouse.*

34. Neotoma floridana, Say and Ord.—*Wood Rat.*—Identified about the year 1866 near New Philadelphia, Ohio,‡ by Dr. R. M. Byrnes, the specimen having been abandoned by a hawk.

35. Hesperomys americanus (Kerr), Coues & Yarrow.§—*Deer Mouse; White-footed Mouse.*—A very common species, nesting just below the surface, generally at the base of a tree; seems to be especially partial

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* Pioneer History, p. 498.

† Indiana Agricultural and Geological Reports, 1869, p. 207.

‡ About 150 miles N. E. from Cincinnati.

§ See Note on nomenclature of this species, by Dr. Coues, American Naturalist, vol. xiii., 1879, p. 784.

to the borders of woodland and the vicinity of running water. A specimen taken at Madisonville on May 13, 1878, contained two well developed embryos. I have observed this species in April still wearing the gray or immature pelage, though full grown and apparently mature.

36. HESPEROMYS PALUSTRIS, Baird.—*Rice-field Mouse.*—On December 18, 1876, I took from the stomach of a Red-shouldered Hawk killed at Madisonville, the posterior half of a body with the tail attached, which I referred to this species. Indubitable evidence of its *former* existence in this vicinity is afforded by the recovery of two well-preserved crania from the "ash-pits" in the Madisonville ancient cemetery. For verification of the identity of the latter I am indebted to Dr. Elliot Coues, U. S. A.

37. ARVICOLA RIPARIUS, Ord.—*Meadow Mouse.*—Our most common representative of the genus; chiefly confined to marshy meadows overgrown with long matted grass, through which its numerous galleries extend in all directions. On March 21, 1871, I removed from a female taken at Madisonville, five embryos, in which gestation had so far advanced that the eyes and extremities were distinctly visible.

38. ARVICOLA AUSTERUS, LeConte.—*Wood Mouse.*—Common. My observations have led me to the conclusion that this species is chiefly confined to wooded or thickety hillsides, where it constructs numerous galleries through and under the fallen leaves and leaf-mold, making its home under some protecting log or stone.

39. ARVICOLA PINETORUM, LeConte.—*Pine Mouse.*—Two or three specimens taken at Brookville, Ind., by Mr. E. R. Quick.

40. SYNAPTOMYS COOPERI, Baird.—*Cooper's Mouse.*—The credit of the discovery of this species *in numbers*,* near Brookville, Ind., now its easternmost recorded habitat, belongs to my friend Mr. Edgar R. Quick, who took his first specimen along a railroad embankment on February 10, 1878. He subsequently found a large colony inhabiting an aboriginal stone mound and its vicinity on the summit of the eminence known as "Brown's Hill," an elevation rising some two hundred and fifty feet above the Whitewater river which flows at its base. In March, 1880, I had the pleasure of visiting the locality in company with Mr. Quick, and observing the species for the first time in its native haunts. We found them distributed over an acre or two of the hillside, and apparently more numerous in and about some marshy

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* A single specimen (date unknown) had previously been taken near the same locality, by Dr. Rufus Haymond, and by him forwarded to the Smithsonian Institution.

spots near the base of the hill, which was contrary to Mr. Quick's previous experience, he having usually observed them in dry situations. They were found in their galleries under logs and limestone slabs and were not very difficult to capture by hand when surprised by suddenly raising the roofs of their dwellings.

The interest that attaches to Mr. Quick's discovery of the species may be inferred from the fact that Dr. Coues was able to obtain but eighteen specimens for study (from the Smithsonian collection), in the preparation of his elaborate Monograph of the Family*; while in European collections the species was almost or quite unknown. Through Mr. Quick's liberality, specimens have since been placed in the Museums of the Zoological Society of London, of the Royal Society of Berlin, and of the Cincinnati Society of Natural History.

41. Fiber zibethicus, Cuvier.—*Muskrat; Musquash.*—A very common species along all our streams, in spite of the yearly trapping of large numbers for their skins, the market price of which ranges from five to twenty cents a piece according to demand and quality. Its food consists largely of our various species of fresh-water mussels of the Genus *Unio*, numerous shells of which may be seen in the neighborhood of its burrows.

The Muskrat is ranked as an undesirable species by reason of its fondness for the young stalks of green corn, large quantities of which it destroys, and also as contributing to the caving of river and canal banks and levees, in which it excavates its dwellings. In still and shallow water, where banks are not convenient, dome-shaped grass houses, rising about two feet above the surface, take the place of burrows; these houses, however, are chiefly seen in flat and marshy districts, being comparatively rare in this vicinity owing to the existence of favorable conditions for burrowing in the banks of our numerous streams.

Family XIII.—Hystricidæ : *Porcupines.*

42. Erethizon dorsatus, F. Cuvier.—*White-haired Porcupine.*—The former occurrence of this species here in considerable numbers is attested by its numerous remains found in the ancient cemetery several times alluded to in the present paper. Mr. E. R. Quick notes a specimen observed by his father, Dr. J. H. Quick, of Brookville, Ind., some thirty or forty years ago and also informs me of more recent evidence

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* Monographs of North American Rodentia, by Coues and Allen.

of its occurrence in the shape of several of its quills seen sticking about the nose of a dog only a few years since. Prof. Kirtland includes it, without comment, in his list of Ohio Mammals of 1838 ; while Dr. Haymond alludes to it as "now very rare" in his "Mammals of Franklin county" (Ind.), 1869.

Family XIV.—LEPORIDÆ : *The Hares.*

43. LEPUS SYLVATICUS, Bachman.—*Gray Hare; Rabbit; Cottontail.*—A very common species, the large numbers slain for market during the fall and winter being amply compensated for by its rapid increase during the summer. Numerous remains found in the Madisonville ancient cemetery.

Sub-class DIDELPHIA: *Non-placental Mammals.*

Order F.—MARSUPIALIA: *The Marsupials.*

Family XV.—DIDELPHIDÆ: *The Opossums.*

44. DIDELPHYS VIRGINIANA, Kerr.—*Common or Virginia Opossum.*—Still somewhat common in this section, its nocturnal habits probably protecting it from extirpation. A young specimen in the writer's collection, taken at Madisonville November 23, 1873, is not much larger than a good sized Norway Rat.

Numerous remains of the Opossum occur among the ashes in the Madisonville ancient cemetery.

B.—A LIST OF SPECIES NOT YET IDENTIFIED, WHOSE RANGE INCLUDES THIS LOCALITY.

Order CARNIVORA: *Flesh–eaters.*

Family FELIDÆ: *The Cats.*

1. FELIS CONCOLOR, Linnæus.—*Panther.*—Although the former residence of this species here is undoubted, its remains have not yet been found, nor have we any positive record of its occurrence in this vicinity. It is mentioned, however, by Kirtland,* Atwater,† Hildreth,‡ and others, as a resident of Ohio.

Order UNGULATA: *The Hoofed Mammals.*

Family BOVIDÆ: *Bovine Mammals.*

2. BOS AMERICANUS, Gmelin.—*American Buffalo.*—The occurrence

* Ohio Geological Survey, 1838.
† History of Ohio, 2d Ed., 1838.
‡ Pioneer History, 1848, p. 497.

of the Buffalo in Ohio about one hundred years ago, is attested by various authorities,* the latest record I have been able to find being that of Hildreth, who states that several were killed near Marietta in 1792. It is somewhat remarkable that its remains have never been found along with those of the various other extirpated species, in the Madisonville ancient cemetery, which is believed to date back from three to six hundred years or more.

Order Chiroptera : *The Bats.*

Family Vespertilionidæ : *The Ordinary Bats.*

3. Corynorhinus macrotis (LeC.) Allen. — *Big-eared Bat.* — Southern United States.

4. Atalapha crepuscularis (LeC.) Coues.—*Twilight Bat.*—Pennsylvania and Missouri, to Georgia and Texas.

5. Vespertilio georgianus, F. Cuvier.—*Georgian Bat.*—Maine and Missouri to Texas.

6. Vespertilio noctivagans, LeConte.—*Silver Black Bat.*—North America.

Order Insectivora : *The Insect-eaters.*

Family Talpidæ : *The Moles.*

19*a*. Scalops aquaticus argentatus (Aud. and Bach.) Coues.—*Prairie* or *Silvery Mole.*

7. Condylura cristata, Demarest. — *Star-nosed Mole.* — The capture of this species at Cleveland, Ohio, and at Meadville, Pa.,† renders its occurrence in this vicinity quite probable.

Family Soricidæ : *The Shrews.*

8. Sorex platyrhinus, Wagner.—"*Common*" *Shrew.*—Specimen recorded from Cleveland, Ohio.‡

Order Rodentia : *Rodents.*

Family Zapodidæ : *Jumping Mice.*

9. Zapus hudsonius, Coues.—*Jumping Mouse.*—Northern United

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* *Vide* Atwater "History of Ohio," p. 67; Hildreth "Pioneer History" (of the) "Ohio Valley," p. 496; Taylor "History of the State of Ohio," p. 88; Col. James Smith, in Drake's "Indian Captivities," p. 189; *et al.*

† *Vide* Baird, in Mammals of North America (P. R. R. Survey, vol. viii.) pp. 74-75.

‡ *Ibid.*, p. 26.

States and British America, in wooded districts ; south to Virginia.* Included, without comment, in Prof. Kirtland's Catalogue of Mammalia, etc., Ohio Geol. Survey, 1838.

Family MURIDÆ: *The Mice.*

10. OCHETODON HUMILIS (Aud. & Bach.) Coues.—*Harvest Mouse.*—Southern United States, north to Iowa.

C.—A LIST OF EXTINCT MAMMALIA, WHOSE FOSSIL REMAINS HAVE BEEN FOUND IN OHIO.

Order UNGULATA : *Hoofed Mammals.*

Family BOVIDÆ : *Bovine Mammals.*

1. BISON LATIFRONS, Leidy.—This animal, a gigantic ox, is represented in the museum of this Society by its fossil horn cores, found in excavating for a bridge pier at Straight creek, Adams county, Ohio, in 1869 : their situation was in coarse gravel, about fifteen feet below the surface. Each core has a portion of the skull attached, which in one case shows a portion of the brain cavity. The following measurements are reproduced from the Society's circular in reference to them, which is not generally accessible:

Length of right horn (core), . .	2 feet, 8 inches.
Length of left horn (core), . . .	2 feet, 7 inches.
Width of forehead, . . .	1 foot, 4 inches.
Entire length of curvature, . . .	6 feet, 8 inches.
Spread of horns to points in direct line,	6 feet, 1 inch.
Circumference at base, ...	20½ inches.
Circumference 10 inches from base, .	16 inches.
Circumference 16 inches from base, . .	14 inches.
Circumference 24 inches from base, .	9½ inches.
Weight, in 1875, 32 and 34 pounds.	

Allowing one foot to each horn for the projection of the horny sheath or point—and this is certainly a very moderate estimate—we have a spread of more than eight feet, which, in connection with their circumference, will serve to convey some idea of the gigantic size and immense power of the animal to which they belonged.

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* *Vide* Coues, in Bull. U. S. Geol. and Geog. Survey of the Territories, No. 5. 1876, p. 261.

Family OVIDÆ: *Sheep.*

2. OVIS MAMMILARIS, Kirtland (?).—This name has been proposed for an extinct sheep, found in excavating for the canal near Nashport, Ohio, in 1838. Its remains, consisting of three crania found at a depth of eight feet in a peat bog, are now in the cabinet of the Athenæum, at Zanesville; I am indebted to Dr. J. M. Wheaton for a sketch and account of it in MS. It is first mentioned, Dr. Wheaton informs me, in Am. Jour. Sci. & Arts, xxxi., 1837, 79-83; the article is anonymous, but is supposed to be from the pen of Dr. Kirtland.

Family SUIDÆ: *The Swine.*

3. DICOTYLES (PLATYGONUS) COMPRESSUS, LeConte.— A species of Peccary, about twice as large as the existing Mexican species, and a little larger than the South American. This animal was discovered in Ohio by the late Prof. John H. Klippart, who obtained twelve nearly entire skeletons within the corporate limits of Columbus, Ohio, in April, 1873. The original account of its discovery read before the American Association for the Advancement of Science, at Hartford, in 1874, was re-published in the Cincinnati Quarterly Journal of Science, vol. ii., No. 1, January, 1875.

Order PROBOSCIDÆ: *Proboscidians.*

Family ELEPHANTIDÆ: *Elephants.*

4. ELEPHAS AMERICANUS, Leidy.—*American Elephant; Mammoth.*— The remains of this species are of rather frequent occurrence in the drift gravel of this region, and it is represented in the Society's museum by numerous specimens. Among these may be mentioned the following: a lower jaw, with a tooth in place, found in digging a sewer at the corner of Fourth street and Central Avenue;* depth ten feet; presented by Dr. O. D. Norton. A tooth, found in excavating for the new Custom House building, in 1875, presented by Dr. H. H. Hill.

5. MASTODON GIGANTEUS, Cuvier.—*Mastodon.*—The remains of the Mastodon, like those of the Mammoth, occur in this immediate vicinity, chiefly in the drift gravel; at other points, however, as at Bigbone Lick, Kentucky,† they are found in place, in such numbers as to have given the locality its name, and many fine specimens now in various museums have been procured there. The bones of the

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* *Vide* Miller, in Cincinnati Quarterly Journal of Science, 1875, p. 266.

† About twenty-five miles S. W. of Cincinnati, or four miles south of the mouth of the Big Miami.

Megalonyx, an extinct Sloth, and those of the Stag, Bison and Horse, are also said to occur there. A large fragment of a Mastodon tooth, found in the ashes of the ancient cemetery near Madisonville, Ohio, is now in the collection of W. C. Rogers, Esq., of that place. Dr. Rufus Haymond mentions the remains of three individuals, found near Brookville, Indiana, two in drift gravel, the third in a piece of marshy ground.*

Order RODENTIA : *Rodents or Gnawers.*

Family CASTOROIDÆ : *Giant Beavers.*

6. CASTOROIDES OHIOENSIS, Foster.—This, the largest of known rodents, was described by J. W. Foster, in 1838,† from a lower jaw and teeth found in digging the canal, near Nashport, Ohio ; its magnitude may be inferred from the fact that the lower incisor measures eleven and one-half inches in length.

Summary.‡

Orders represented	Existing	5	
	Extirpated	1	
	Extinct	1	
			7
Families represented	Existing	12	
	Extirpated	5	
	Extinct	4	
			21
Genera represented	Existing	29	
	Extirpated	9	
	Extinct	6	
			44
Species represented	Existing	43	
	Extirpated	11	
	Extinct	6	
			60

* Indiana Agricultural and Geological Reports, 1869, pp. 199-200

† *Vide* "Second Annual Report on the Geological Survey of the State of Ohio." Columbus, 1838, pp. 80-83.

‡ Including list B, which contains 10 species not yet identified, but of probable occurrence here, five of which have been identified within the State ; and list C, of which four species have not been identified in this vicinity.

DESCRIPTION OF FIVE NEW SPECIES OF SILURIAN FOSSILS, AND REMARKS UPON AN UNDETERMINED FORM.

By S. A. MILLER, Esq.

ORTHODESMA CUNEIFORME, n. sp.

Plate VIII., fig. 1, view of the right side of a cast; fig. 1*a*, view of the anterior end.

Shell very large, equivalve, very elongate, cuneiform, ventricose, and possessed of strong incurved beaks at the anterior end. The cardinal line is at an angle of about fifty-four degrees from the basal line. The beaks unite over the hinge line, at the extreme anterior part of the shell, leaving a distinct lunule below. The greatest thickness is at the anterior third of the shell, and from this point posteriorly the shell is wedge-shaped.

The length is 3 15-100 inches, thickness 1 4-10 inches, and height a little greater than the thickness, but as our specimen is a cast, and somewhat injured on the basal line, we are unable to give the exact height.

The species is founded upon a single specimen, having no part of the shell preserved, which I collected several years ago, in the upper part of the Hudson River Group, near Versailles, Indiana. It may not be a true *Orthodesma*, but its relations seem to be nearer to this genus, than to any other found in rocks of this age. Muscular scars not observed.

CLEIDOPHORUS CHICAGOENSIS, n. sp.

Plate VIII., fig. 2, view of the right side of a cast: fig. 2*a*, dorsal view. These illustrations are not satisfactory, and fig. 2 is specially defective in giving a view as if depressed, instead of showing the true gibbous character of the fossil.

General form of the shell, sub-elliptical, anterior extremity narrowed, broader posteriorly, base regularly rounded, very ventricose in the umbonal regions, and down the posterior umbonal slope. Beaks highly elevated, hinge line slightly arched but arcuate, in front of the beaks, where the lunule is strongly marked. The depressed line indicating the place of the clavicle, extends from the cardinal margin, anterior to the beaks, half way to the base. The elevated ridge extending from the beak to the posterior basal margin, and constituting the gibbous portion of the shell, fades away gradually toward the anterior and basal margins, and abruptly toward the hinge line. A depression

in the cast on each side of the cardinal line, shows the thick and firm character of the shell at the hinge line.

A large specimen has a length of 2 2-10 inches ; thickness, 1 2-10 inches, and height about the same. The specimens differ a great deal in size.

There are indications on the casts of concentric lines, with which the surface of the shell was probably ornamented.

Collected by W. C. Egan, of Chicago, Illinois, in rocks of the age of the Niagara Group, at Bridgeport and Cicero, Illinois.

AMBONYCHIA ROBUSTA, n. sp.

Plate VIII., fig. 3, view of the right side of a cast, though too much depressed in appearance, and not showing as it should the abrupt bending over of the shell on the anterior side; fig. 3*a*, view of the anterior side of the shell.

Shell large, very ventricose, anterior side flattened and depressed in the region of the byssus; beaks acute, triangular; posterior wing, short, muscular impression high, and surface marked by about forty simple radii, which are crossed by fine concentric striæ.

This species is distinguished by its large size, triangular beaks, flattened and depressed anterior side, and high position of the muscular impression.

The specimens are quite variable in size, but a medium specimen has a height from base to beak of 2 6-10 inches and thickness of 1 8-10 inches.

Specimens having the shell quite well preserved, occur in the upper part of the Hudson River Group, near Osgood, Indiana, where I collected the type specimens. And I refer the large casts having a flat anterior side, which occur at Richmond, Indiana, to the same species, though they have a greater height in proportion to their length and thickness.

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Plate VIII., fig. 4, view of two joints or parts of a peculiar fossil; fig. 4*a*, a sectional view showing the radiating or fibrous structure.

This singular fossil was collected by W. J. Paterson, Esq., in the Hudson River Group, at Cincinnati. He found six joints or sections.

The structure is not that of the shell of a *Cephalopod*, nor indeed that of any other fossil shell with which I am acquainted. At first glance one is likely to suggest that it is the siphuncle of an *Orthoceras*, but a little inspection dispels this illusion. The thickness is nearly a quarter of an inch, and appears to be composed of fibres, not unlike in appearance some specimens of stalagmite. I do not, however, see how it can

be considered as an inorganic substance on account of its peculiar form and the number of specimens discovered. If it is organic, it is certainly an anomaly. I have had the specimen in my possession for the past two years, without any determination of its character, and I now illustrate it, hoping that some one may suggest its true relations or affinity.

CUNEAMYA PARVA, n. sp.

Plate VIII., fig. 5, view of the right valve; fig. 5*a*, cardinal view of the same specimen.

Shell small, equivalve, dorsal view sub-elliptical in outline, side view half cordiform, much the largest anteriorly, and cuneiform from the anterior third to the posterior end. Valves ventricose in the umbonal region, the umbonal ridge extending along the middle of the shell until it fades away at the posterior end. Beaks proportionally large, and projecting over the cardinal line until they come in contact near the anterior end of the shell. Anterior end rounding from the lunule into the base. (The illustration is not exactly correct in this respect.) Cardinal margin straight from the beaks posteriorly about two thirds of the distance to the posterior end, and sub-parallel with the base; the valves are so inflected as to form a narrow false area or escutcheon behind the beaks. Surface ornamented by concentric striæ, which commence at the inflection of the lunule, and sweeping around the umbonal ridge, bend forward and terminate at the elevated cardinal margin or rim of the false area or escutcheon.

Length of a specimen, 55-100 inch; height, 22-100 inch, thickness, 28-100 inch.

This specimen is in my collection, and was found in the lower part of the Hudson River Group, at Cincinnati, Ohio.

ORTHODESMA OCCIDENTALE, n. sp.

Plate VIII., fig. 6. view of the right valve: fig. 6*a*, dorsal view of a cast.

Shell very small and thin, cardinal and basal margins sub-parallel; hinge line straight, posterior to the beaks, and about three-fourths the length of the shell; anterior end declining forward from the beaks to a point, and then rounding off into the base; posterior end rounded; beaks extending above the hinge line; umbones flattened, and sending an angular ridge forward to the base, and a rounded swelling posteriorly, which fades away toward the basal extremity.

Surface marked by strong concentric lines, or imbricating marks of growth which are distinctly retained on the casts. The illustration,

fig. 6*a*, is incorrect, in this, that it shows more concentric lines near the beak than appear on the specimen.

Length, 6-10 inch ; height, 28-100 inch ; thickness, 18-100 inch.

This species may be readily distinguished from others in this genus by its small size, strong, concentric lines, and thin, sharp, prow-like projection of the anterior end.

I collected this species in the lower part of the Hudson River Group, at the excavation for Columbia Avenue, in Cincinnati, at an elevation of about 140 feet above low-water mark of the Ohio river.

ON THE GEOGRAPHICAL DISTRIBUTION OF CERTAIN FRESH-WATER MOLLUSKS OF NORTH AMERICA, AND THE PROBABLE CAUSES OF THEIR VARIATION.

By A. G. Wetherby, A.M.,

Prof. of Geology and Zoology, University of Cincinnati.

Few subjects connected with the study of plants and animals have presented questions of greater interest than that of their geographical distribution. To work out these problems, naturalists have consented to absent themselves from civilization and home for years ; to wander through the deserts of the semi-tropics, the thick jungles and forests of equatorial regions, and over the ice-floes and glaciers of the ultimate attainable polar climes ; and from these extremes, whatever the untiring vigilance of trained workers in special fields has been able to glean, they have brought together, analyzed, compared, and so set in order, as to bring the earth's wide spread glory of organic life into something approaching a comprehensive system.

The result of this labor has been to show that species are not the unchanging certainties that the earlier students of the earth's races believed them to be; that, in fact, the word species is little less than "a convenient abstraction" by which we separate from the multitude of life around us, certain individuals having common characters over limited areas.

The statement of Forbes, that "every true species presents in its individuals certain features, specific characters, which distinguish it from every other species, as if the Creator had set an exclusive mark or seal on each type," can not now be used in the sense set forth, unless

the definition be applied to a number of existences so infinitely small, when compared with the living myriads around us, as to be absolutely fatal to it by contrast.

The belief of the past, that all species are immutable productions, originating from points within the limits where they are now found, and which have spread from specific centers to the limits of suitable conditions, their areas thus being larger or smaller, according to circumstances, made a reference to potential physical factors of the past a necessity; and it required a belief in the effect of these changes, of whatever nature it may have been, as a restriction upon the limits of distribution. Recent reasoning but enlarges this field of view, in accordance with our wider information as to the capacity of animals for adaptation, and their proneness to variability; these factors rendering it possible for animals to overstep any artificial obstructions raised by the imagination, and tending to render the phrase "limit of suitable conditions," an exceedingly uncertain boundary.

The relations existing between species and distribution are now so generally recognized, that I need say nothing farther in the way of an introduction to this discussion. It would appear that all these questions become of paramount importance in the study of our fresh-water mollusca, because they have always been subjected to a series of causes from which, on account of their peculiar station, they have been more or less powerless to escape; and that, in consequence of this, they have exhibited a high degree of capacity for adaptation, with a maximum variability of form as shown by their present development. It is, therefore, a field of special interest, to which this paper briefly calls attention.

It seems desirable to discuss these points in some order of succession, that we may harmoniously present the facts to those who may be interested in them. In the present paper, I shall confine myself to the families of the *Unionidæ*, and *Strepomatidæ*, which have a wider or more general distribution than the other fresh-water groups. Beginning our consideration of this question with the New England States, we find no representative of the *Strepomatidæ*, and very few of the *Unionidæ*. Such of the latter as we do find, are of the types that occur in a multitude of varietal forms, along the Atlantic slope, east of the Appalachians, with a few having a wide westward and southward range. But among these shells occurs one remarkable anomaly of distribution in the presence of the *Margaritana margaritifera*, Lam., an European species which occurs in the New England

States, and though wanting across the whole interior of the continent, re-appears in the drainage of the Pacific slope. Westward, as far as the State of New York, we have a few species added to the New England list of *Unionidæ*, and a new faunal factor in the presence of four species, and three genera of the *Strepomatidæ*. It is worthy of remark, that, as the present understanding of these shells goes, two of these species of *Strepomatidæ* are widely distributed over the northern States to the west, while the other two have their range to the south, along the western slope of the Appalachians, to Pennsylvania, Virginia, etc. The same fact is to be observed with regard to the *Unionidæ* of New York, several of the species belonging especially to the Appalachian drainage, while others have a wide western and southern range.

We may now direct attention to the Ohio drainage. The number of described species of *Unionidæ*, from North American localities, in 1874, including those in Mr. Lea's vol. xiii., was 832, of which 82 were described from the Ohio river, exclusive of 10 or 15 species from the Scioto, Wabash, and other *northern* tributaries. Of these 70 were *Uniones*, 7 *Margaritanas* and 5 *Anodontas*. It is thus seen that one tenth of all species described have been from Ohio river types, and in very many of these cases the words "at Cincinnati" are added. When the wide system of drainage from which our river receives its waters is taken into account, a region embracing the whole western slope of the Appalachians, from southern New York to the northern part of Georgia, and including not only wide climatic variation, but an infinity of other conditions, depending upon previous geological causes, it will not be out of the province of facts to say that here we have the most important field for study. Now, what are the phenomena which it presents ? Pushing our inquiries westward, across the States of Indiana, Illinois, etc., to the base of the Rocky Mountain plateau, we find that the fauna is essentially that of the Ohio river at Cincinnati. There are a few species (?) interpolated across this region, and in the Wabash two forms of *Strepomatidæ* at least are found which belong to the Southern part of the Ohio drainage, and really to the mountainous portion of it. Across this western range we find the shells to be very much varied in weight, size, nacreous color, outer marking, and perfection of form, it being as rare to find an "eroded" shell in the Wabash, White river or Saugamon, as to find a perfect one in the Ohio. Into the literature of these shells has crept a large synonymy, which reaches both the families under consideration, and is the result of

earlier want of knowledge in regard to distribution and variation as applied to them.

One remarkable fact should not be forgotten; that we begin with a prevalence of *Anodontas* at the east and northeast, which continues across the northern part of the western distribution, while the southern part finds these forms largely outnumbered by the *Uniones*, but with the *Anodontas* re-appearing again in the west as the most representative forms; and this statement, here referring to that portion of the drainage north of the Ohio, is much more apparent throughout the rest of the area now under consideration. If, now, we consider the shells of the eastern slope of the Rocky Mountain plateau, and the plains of the Mississippi, from the north southward, through Missouri and Arkansas into Texas, we shall find, all the way through, a predominance of Ohio river types; and I seriously doubt whether there is a single species in this whole range, outside of them, in any part of this wide drainage, that is anything more than a variety of easily recognized Ohio forms; and these remarks especially apply to the Texas shells, which certainly abound in local varieties of Ohio types.

In summing up the evidence upon which this statement rests, it should not be forgotten that even in those streams which present the greatest number of species not found in the Ohio, and which may thus be called abnormal, the central group, that containing the largest number of species, is the group made up of typical Ohio river forms ; and this remark applies, without exception, to every stream throughout this wide range, from Ohio westward to the limit of the Mississippi drainage, and southward to the western borders of Texas. These remarks must mainly apply to the *Unionidæ*, as there has been a much more limited westward distribution of the *Strepomatidæ*, though the few species hitherto collected from the western slope of the Mississippi basin and Texas, are referable, with the possible exception of a single species more nearly allied to the Mexican fauna (?), to types east of the Mississippi.

If, now, leaving this portion of our field, we direct attention to that part of the Ohio drainage which lies south of that river and east of the Mississippi, remarkable changes at once begin to present themselves.

The first and most important of these is the appearance of many new species and several genera of *Strepomatidæ*, and the excessive differentiation of certain forms, which, from their prevalence, may be regarded as central or typical, this introduction and differentiation beginning before we have crossed the State of Kentucky, and continuing through

Tennessee, and to the southern and eastern limits of the Ohio drainage. Here it is that we begin to meet with those forms about whose specific rank there can be little reasonable question, though it is a self-evident fact that nearly or quite fifty per cent. of the so-called "species" of this region, are local varieties of the central types mentioned above.

In considering the fauna of those streams presenting the greatest number of forms claiming specific rank, we can always separate them into two or more groups having a distinct facies ; and in all cases, one of these groups will be that of typical Ohio river forms.

I do not, in this consideration of the matter, refer to special cases of form, such as "oval," "quadrate," "wide," etc., terms used by Mr. Lea in his grouping of the *Unionidæ*, but to a certain general stamp or character, which belongs to larger groups, holding often many of these "forms." It is impossible for the collector, who has waded through these interminable variations, as well as the streams containing them, not to be struck with the force of this fact, and to have it continually brought before him, as if there was a commingling of faunas, widely enough separated to lead to comparison with different areas and systems of drainage, or to suggest the mingling of species from such systems. In some of the streams, even comparatively small ones, a predominance of these abnormal groups exists ; and there may even be in very small streams, an entire absence of the Ohio types. In considering the present distribution of these mollusks, we find an infinite variety of conditions as we pass from stream to stream, and we discover, as the result of this, many local varieties that doubtless owe their origin to these causes ; but there are other groups that are evidently related to some remoter source. These are those which, in the *Unionidæ*, may have no separate generic characters, but which, in the *Strepomatidæ*, have been stamped as having higher value than that of mere varietal distinction.

In this connection we have such problems to deal with as the presence of the *Unio spinosus* in the Altamaha river alone, at the southern end of the Atlantic slope of the Appalachians, and of the *U. collinus* in New river of Virginia, on the western slope, far to the north. These are, I believe, the only spinous species of the family known. Neither has any distribution, yet discovered, beyond the stream in which it was first found. The case of the *M. margaritifera* has already been cited. Other cases equally remarkable exist, which it is not necessary to quote here. There is, also, this further fact to be observed; that many streams contain species not found in contiguous ones, a fact

which seems to me to have a much greater significance than is to be attached to merely local causes, or those of present or comparatively recent action.

We may now pass to the consideration of streams outside of the Ohio and Mississippi drainage, and among these the most anomalous is the Alabama, from whose prolific waters 184 species have been described, not half of which are more than the merest varieties.

But here we meet with two genera, not yet found elsewhere, and embracing a list of about 30 described species. If this fact stood alone, we might not regard it as exceedingly anomalous; but with it is the testimony that these two genera, *Schizostoma* and *Tulotoma*, as well as the peculiar species of *Goniobasis* associated with them, belong to a fauna of separate origin from many of the *Unionidæ* found as their associates in the same stream. I am well aware of the fact that this statement rests upon synonymy which some American students of Coosa and Alabama river shells do not recognize; but it is nevertheless true, that a large number of species belonging to the Ohio drainage have their varietal forms in the Gulf system of Alabama, almost as plainly indicated as in that portion which belongs to Texas. The species from Florida are different, and no Ohio river type exists there. When we consider the shells of the Atlantic slope, though a large number of species has been made of them, it is not difficult to demonstrate a very numerous list of synonyms among the *Unionidæ*, until we have reached the southern borders of North Carolina, where a new fauna begins to appear, that culminates in Southern Georgia and Florida, having a very marked series of *Strepomatidæ*, quite distinct from the Ohio drainage by its want of the genera *Pleurocera* and *Anculosa*, and the introduction of many species of *Unionidæ* not readily referred to Ohio types. This region contains the *U. spinosus* already mentioned, and a number of species far removed from the ordinary types of their genera, as the *U. shepherdianus* and the *Marg. arcula*, etc.

When the fresh-water shells of the west coast are examined, we find the families under consideration to have but few species, and these embracing some forms of very great distinctness, as the *Anodonta wahlamatensis*, *A. angulata*, *Goniobasis plicifera*, and *G. occata*. The only species of *Margaritana* is the *M. margaritifera* before mentioned.

In summing up the facts which extensive collections of these shells from authenticated localities set forth, one prominent one presents itself; and that is, that many of the species never present any varietal differ-

ences that in the slightest degree obscure their character, or give rise to a suspicion of new species. Of the Ohio types that are thus specifically persistent, may be mentioned the *U. tuberculatus*, *U. cylindricus*, *U. irroratus*, *U. anodontoides*, *U. cornutus*, *U. rectus*, *U. triangularis*, *Marg. dehiscens*, etc.

This is not a statement that these shells have no varieties, or local differences; but it is a fact that none of these have ever presented any varieties that would lead to the suspicion of species. As these are all shells belonging to the group of Ohio types, this truth in the light of additional ones, may prove to be a factor of considerable consequence. As opposed to this fact, may be mentioned the opposite one, equally well attested, that many of the Ohio types present a very great range of variability, and have given rise to an immense synonymy.

We have now before us a series of facts which may be briefly epitomized as follows:

First—The small number of species of *Unionidæ*, and the entire absence of *Strepomatidæ* in the New England States, and the fact of the distribution of some of the former entirely across the continent to the Pacific coast, and southward along the Atlantic.

Second—The introduction of the *Strepomatidæ*, west of the Green Mountain uplift, and their division into two geographical groups, one pertaining to the western, and the other to the southern fauna.

Third—The continuance of the Ohio types of *Unionidæ* westward, north of that stream, to the limits of the Mississippi drainage, and south and southwestward to western Texas, and the comparative absence of the *Strepomatidæ* over this area.

Fourth—The introduction of new species in both families, and of new genera in the *Strepomatidæ*, so soon as we cross the Ohio and travel south.

Fifth—The *facies* of the groups of species which the streams of this part of the Ohio drainage contain, stamping them as different faunas.

Sixth—The anomalous fauna of the Alabama drainage, and especially the fact of its geographical isolation.

Seventh—The special cases of the only species of spinous *Unio* known, and that of the *M. margaritifera*.

Eighth—The persistent specific character of some mollusks, and the excessive evidence of variation in others.

In looking over this summary, as sustained by large collections and extensive experience in collecting, an experience that included geological examinations of all the districts, it appears certain that other

causes than those now in existence have operated to produce the results thus traced out, and that the solution of the whole question of the anomalous distribution, excess or want of varietal characters, and abundance or paucity of species, must be sought somewhere else than in the causes to which these facts have usually been ascribed.

I am well aware that the results above presented are but a few of those to which this study leads ; but I am also aware that a satisfactory solution of the questions indicated is far from being an easy matter ; and that if a reasonable solution can be offered, it will be a key to many of the troublesome questions connected with species, and this solution I hope to attempt in a future paper.

DESCRIPTIONS OF CRINOIDS FROM THE UPPER SUB-CARBONIFEROUS OF PULASKI COUNTY, KY.

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In the Bulletin of the Royal Academy of Belgium, vol. viii., pt. 2, p. 13, 1858, Dr. L. De Koninck. the illustrious palæontologist, published his description of the genus *Hydreionocrinus*, and illustrated it with figures of various species.

A careful study of his figures and description seems to suggest that the specimens which he had under consideration were not in a condition sufficiently perfect to determine or indicate all their characters. At all events, there are many reasons for believing that specimens which I have collected in the upper part of the Chester Group of the Subcarboniferous, in Pulaski county, Ky., and which had been, previous to the appearance of Mr. Wachsmuth's Revision of the Palæocrinoidea, referred to *Zeacrinus*, may belong to the genus established by Dr. Koninck.

Though Mr. Wachsmuth, to whom I have sent specimens of these crinoids, refers them to the species described by Meek and Worthen, under the names *Zeacrinus armiger*, Proc. Acad. Nat. Sci. Phil., and *Z. depressus*, Troost, as defined by Hall, Geo. Rep. Iowa, vol. i., pt. 2, p. 546, I have every reason to believe that this reference is incorrect, and that the fossils here figured are undescribed species. I do not, however, forget Mr. Wachsmuth's claim to be regarded as the highest American authority on these fossils, and refrain from adding any new

names to the forms herein described at present, the more especially as I have had no authentic examples of the two species above mentioned with which to compare the specimens now under consideration, and must, therefore, rely upon my own interpretation of the descriptions and figures in illustration of the species mentioned. I propose, in this paper, carefully to describe the two species from very perfect examples, and a series of sliced specimens which exhibits all their peculiarities of internal structure, hoping thereby to place before the students of our subcarboniferous crinoids the fullest possible information about the genus to which these forms unquestionably belong. Dr. Wachsmuth, in the volume above referred to, gives a very full discussion of what he calls the "typical form," and places under it the two species to which reference is made above. It will be seen, if a careful comparison is made with what is here written, that his general description contains reference to few characters not indicated by the specimens described in this article. If we have, however, a very full and perfect series of specimens, we can not fail to observe that striking modifications of the body accompany the equally striking modifications of the dome, or upper, umbrella-like expansion, covering the distal end of the ventral sac.

The species to which Dr. Wachsmuth gives the name *H. depressus*, is represented on the plate accompanying this article, by figures as follows: Fig. 1, side opposite the azygous area; fig. 2, azygous side; fig. 3, top of dome, from which the spiniferous marginal plates have been removed; fig. 4, basal view, showing the length of the broken brachial spines; fig. 6, vertical section of a specimen through the ventral sac, showing, first, the pores perforating the plates at the sutures; second, at "*a*" these pores cut across; third, the lower plates of the ventral sac, resting upon an arch of plates which is continued over the cavity of the body, from the inner ventral plates, which may be seen upon the right of the figure cut in vertical section.

The description of this species may be formulated as follows: no reference being had to its identity with any species hitherto described

HYDREIONOCRINUS DEPRESSUS, Troost (Wachsmuth non Wetherby).

Under-basals—Five, small, nearly or quite concealed by the column upon the outside, and forming the base of "a deep concavity" within which the latter is attached; the upper or inner side of these plates is expanded and flexed outward so as to form a portion of the base of the cavity as seen from the inside.

Basals—Five, pentagonal, of nearly equal size, petal-like, the upper

two thirds being bent on the lower so as to stand nearly at right angles to it in the natural position of the specimens, and forming the side boundary of the almost tube-like basal depression. The upper end of four of these plates is acutely oval, so that this extremity can only be said to have two faces by virtue of its occupying a concavity formed by the excavated faces of the contiguous radials. The sides of the vertical two thirds of these plates are concave toward the stem, or columnar cavity, and are seen to be convex inwardly in section. The fifth is similar to the other four. except that its upper extremity is truncated for the support of the second azygous plate, and that it is somewhat larger. These plates form a five-leaved flower-like base, similar to that seen in true *Zeacrinus*.

Radials—Five, somewhat wider than high, pentagonal, nearly equal in size and shape, that on the right of the azygous area resting upon one basal, the others resting upon two. These plates are convex and thickened outwardly, and separated from the brachials by wide external sutures.

Brachials—Five, four pentangular. that opposite the azygous area quadrangular; the first four are spiniferous, and from their position, and the size of the spines, give the basal view of the specimens a quadrate outline as seen in fig. 4. These plates meet laterally, and each bears upon its upper sloping sides the large quadrangular first arm-plates, which are wanting in case of the other, upon the upper sides of which rests a series of small plates, such as follow the large arm plates in the other four.

Arms.—The ten arms, resting upon the brachials, are divided as follows, above these plates, the divisions always taking place on the sides opposite the sutures between the brachials, or toward the suture joining the large arm plates resting upon each brachial. The first pair of arms on the right of the azygous area gives rise to nine arms, five on the left and four on the right; the second pair to nine in the same manner. The first pair on the left of the azygous area to nine arms, five on the right and four on the left; the second pair to nine in the same manner.

The remaining pair, which is that opposite the azygous area, gives rise to six arms, three upon either side. These subdivisions, very perfectly shown in the specimen, are not so well indicated in the figures 1 and 2. This is as far as the divisions of the arms can be traced, and it gives us 42 arms at the free extremities. Each new subdivision rests upon a large spine-bearing plate, the articulating surface sloping toward the dividing side. This arrangement renders the sutures con-

tinuous between the rays from the basal plates to the dome, and the sutures between the arms continuous from the first subdivision of the rays, or from the apex of the brachials upward. Thus the first arms, or the contiguous ones over the brachials, are the longest in each ray. This is the same arrangement of the arms that we have in typical *Zeacrinus*.

The Azygous area.—This consists of five hexagonal plates, arranged in two series as exposed, the lower plate upon the right. In section these plates are seen to be the base of a dome-like support of the ventral sac, which, as may be seen from figure 6, where the azygous plates are represented upon the right, is continuous over the lower part of the body cavity, arching in all that part below the upper surface of the radials. These plates are greatly thickened, a fact which, as well as their articulation with the inner ledge of the brachials, is not correctly represented in the figure. The lower extremity of the ventral sac is inclined to that part of the dome adjacent to the azygous side, to such an extent, that the azygous plates are practically continuous with the walls of the lower extremity of that organ. They are, consequently, the exposed lower part of its parietes here as in other genera.

The Ventral Sac.—This is composed of plates which are mostly hexagonal, thicker above and below than in its central part, and which have their sutures perforated at the angles by pores communicating with the interior (see fig. 6*a*).

This structure tapers from the lower extremity to a constriction somewhat below the middle, whence it widens outward to the top, where its diameter is three times that of the middle portion. The cavity inside has the same form as the exterior, being very much contracted in the center, and widened above and below. No connection of this cavity with that below it has yet been discovered. The top of this sac is covered with a set of quite regularly hexagonal plates, which do not, as may be seen by figure 3, exhibit any definite order of arrangement, nor do they agree in number or size in different individuals that may readily be referred to this species. The outer plates are terminated by spines which project far beyond the periphery of the arms, and are somewhat bent downward, or arched toward the base like the ribs of an umbrella, though in a less degree. They were very delicate, and are rarely preserved upon specimens not imbedded in the matrix. In specimens having the sac roofed by 24 plates, there are twelve of these marginal spiniferous ones.

The Pinnulæ.—These appear to be short and stout, as described by

Dr. Wachsmuth, the habit of the species, and indeed of the genus, being such as to give the arms and like parts a comparatively short and strong character.

The Column.—This is small, pentagonal, and composed of nearly equal plates, which are alternately larger and smaller near the body, giving the column a ringed appearance.

As but an inch or two of the column has been observed, further characters can not be given it. The proximal portion is invariably bent to one side of the columnar cavity, and in contact with its plates.

Of this species I have found many specimens of various ages and sizes, of which the essential characters are given above. Some of the younger specimens have the spines very beautifully preserved, and it seems that this character of ornamentation reached its maximum of development in the curious crinoid above described.

HYDREIONOCRINUS ARMIGER, Meek and Worthen (Wachsmuth non Wetherby).

Under-basals—Five, small, outwardly entirely concealed by the base of the column, which almost completely fills the small excavation; inwardly they have much the same construction as in the species above described.

Basals—Five, three pentagonal, the two on the azygous side hexagonal, being made so by the truncation of their upper extremity, upon which the lower plates of the azygous series rest. They are nearly equal in size, and flexed in the middle so that one extremity points upward into the columnar excavation, and the other upward upon the outside of the body; this gives the central part of these plates a convexity which imparts to the base of this species one of its distinguishing features.

Radials—Five, pentagonal, wider than high, equal in size, and each articulated across its entire upper face with the brachial of the same ray, as may be seen in plates 7 and 8.

Brachials—Five, pentagonal, wider than high, and each bearing upon the upper sloping sides the large plates of the arm series as in the species above described. Each of these plates has its outer surface, at the upper angle, prolonged into a stout spine, as may be seen from figure 7. The upper part of these plates, forming the base of the spines, is much thickened, so that the body of the crinoid gradually widens upward to this point as shown by figures 7 and 8.

Arms—Ten, resting upon the sloping upper surfaces of the

brachials, and subdivided as follows, the subdivisions being on the same side as in the preceding species; the first pair, to the right of the azygous area, gives rise to 6, three for each arm; the second pair to the right, also gives rise to 6, three for each arm; the first pair to the left of the azygous area is divided in the same manner; in the second pair there is usually the same arrangement, but in one case the following anomaly occurs: the right area gives rise to two branches, which have no further division; the left gives rise to three, two of which are again subdivided, giving rise to 6 at the free extremity. The pair opposite the azygous area is again divided, giving rise to four arms; we thus have, in several cases, 30 arms at the free extremities. The plates upon which these divisions take place are in no case spinous, though thickened and larger than the other plates of the arm series.

The Azygous Area.—This is similar to that in the species above described, though less prominent. Its connection with the ventral sac, and relation to other internal parts have not yet been made out.

The Ventral Sac.—This is similar in form to that of the previously described species, except that it is divided longitudinally into a series of grooves separated by acute ridges, within which grooves the arms or pinnulæ are folded ; this feature of the organ is indistinctly shown in the upper part of fig. 8, at the left, where the extremity of the sac may be seen just beneath the edges of the dome plates. The roof of this organ may consist of five spine-bearing plates, as seen in fig. 9, which represents the top of fig. 8, or of 7 plates, as in other specimens, or of 8, as seen in fig. 11 ; the latter specimen, however, was found apart from the crinoid to which it belonged. It is plain that the number of spines or of dome plates can not be regarded as a specific character. As may be seen by the figures cited, these spines are very long and slender.

The Pinnulæ.—These are longer and less stout, accordingly, than in the preceding species, from which this differs in its more elongated habit.

The Column.—This is pentagonal, and very much resembles that of the preceding species.

This crinoid may be distinguished from the previous species by its greater size, more slender habit, want of spines on the arm-dividing plates, fluted ventral sac, more rounded and comparatively small body, smaller number of free arms, and by the much smaller number and greater size and thickness of the top plates of the ventral sac, with their greatly elongated spines. Altogether it is one of the most grace-

ful and beautiful species of crinoid that I have yet found in the upper subcarboniferous. It is far less numerous than the species above described.

POTERIOCRINUS MILLERI, nov. sp.

Under-basals—Five, small, pentangular, nearly concealed by the column.

Basals—Five, pentangular, equal in size, small, about as wide as high.

Radials—Five, pentangular, wider than high, equal in size, thickened above, and united with the brachials by widely gaping sutures. These plates are incorrectly represented in the figures 12 and 13, as they are pointed below.

Brachials—Five, pentagonal, much higher than wide, laterally constricted above their basal articulation, and each bearing upon its upper, sloping sides, a pair of arms.

The Arms—Ten, stout, long, composed of heavy irregularly pentagonal plates, of which the form is best indicated in figure 12. Each gives rise to a comparatively long and heavy pinnule. They are continuous without divisions to the tips.

Pinnulæ.—These are heavy and long, and composed of regular, quadrangular plates. Their manner of origin, from lateral processes of alternating arm plates, gives this species its peculiar appearance.

Azygous Area.—This is comparatively large, exposing seven quite regularly hexagonal plates in one specimen. As may be seen in the same specimen, they are continued upward into a ventral sac which is probably as long as the arms, but none of the specimens are in a condition to indicate anything further in relation to them.

The Column.—This is small, round, and evidently composed of equal, thin plates. But a small portion, near the body of the crinoid, has been found.

This species has no very near relation, more than generically, with any hitherto described. The specimens found were in a poor state of preservation, and imbedded in a hard matrix. They were slightly defaced in the process of removal, but enough of their distinctive characters remain to determine their right to specific rank. The body is comparatively short and round; the plates exhibit evidences of tubercular sculpture, neither of which facts appear in the figures. The species is evidently rare, but few specimens having been found. I have great pleasure in dedicating this species to my friend and fellow-worker, S. A. Miller, Esq.

Locality and position of all the above: Upper part of the Kaskaskia (Chester) Group, subcarboniferons, Pulaski county, Ky.

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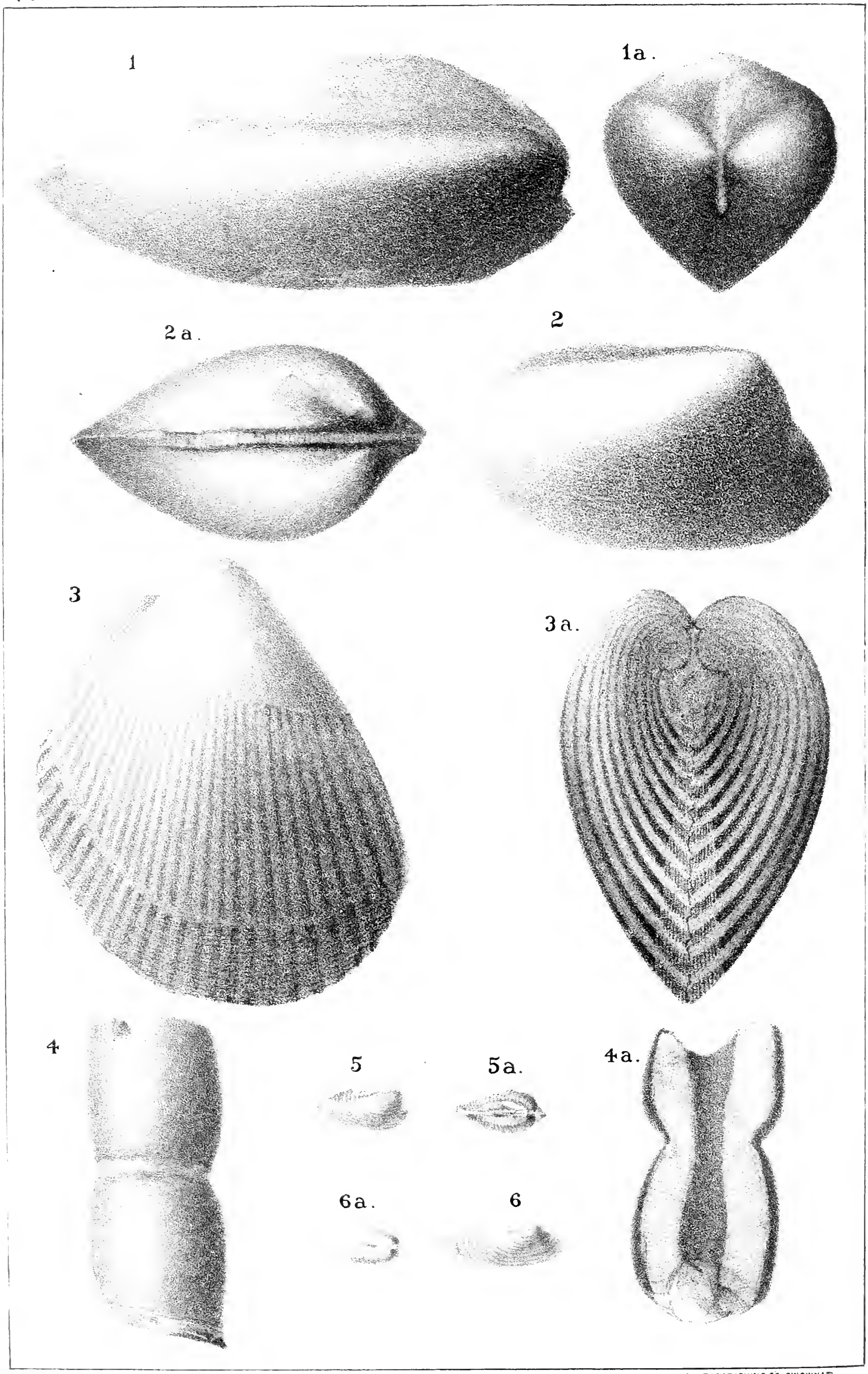

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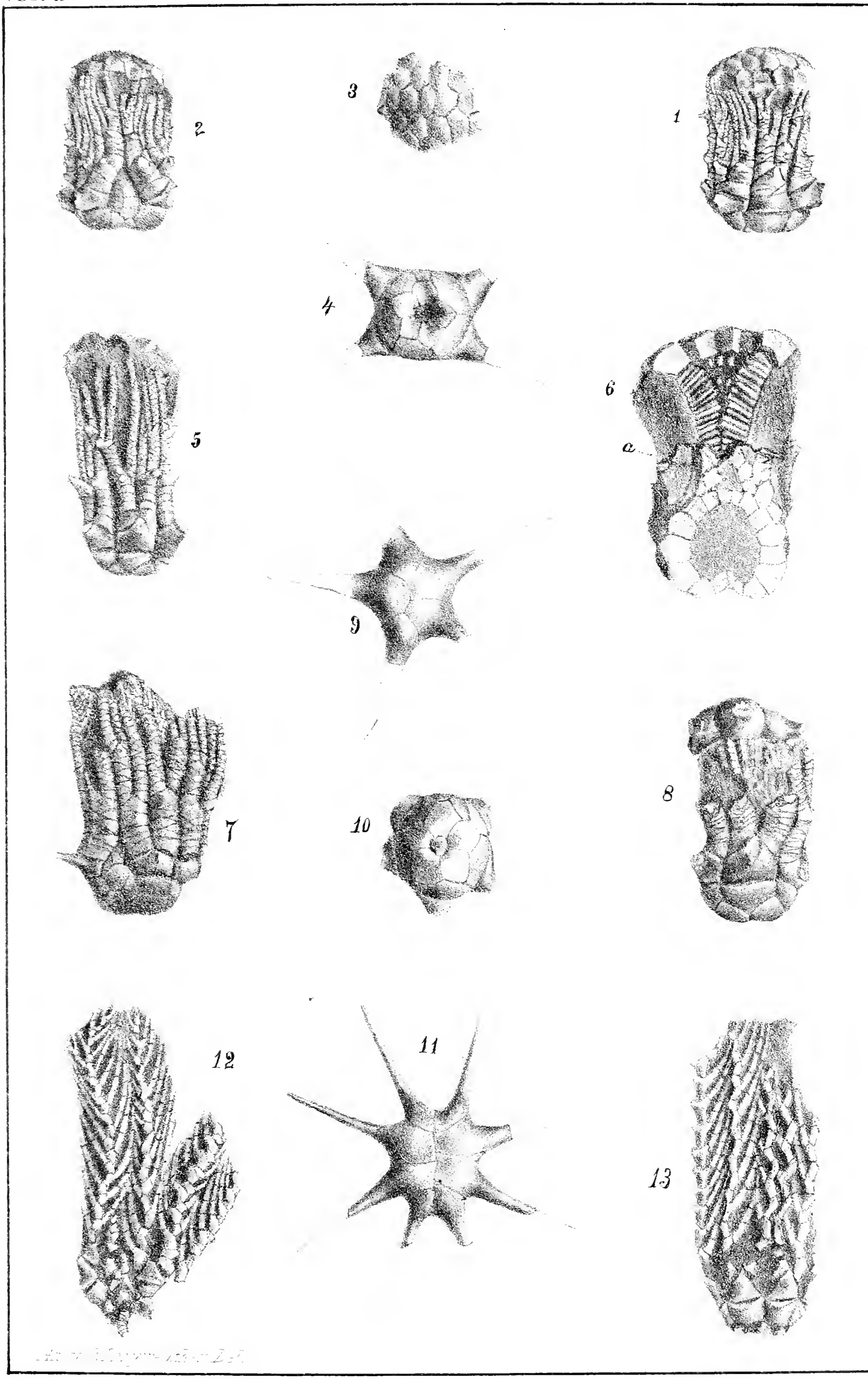
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